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JACA Corp.,
Fort Washington, PA

Prepared for

Industrial Environmental Research Lab.
-Cincinnati, OH

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Research and Development

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Prepared for

Office of Pesticides
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Prepared by

Industrial Environmental Research Laboratory
Cincinnati, OH 45268

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The EPA asbestos/asbestiform research program encompasses a wide range of activity directed toward the control and management of mining, milling, processing, fabricating, and end uses of asbestos. Widespread applications of asbestos in the past have exposed large segments of the population to unknown risks. Research should provide valuable answers to numerous questions related to the use of and the exposure to asbestiforms. Access to important research information is a necessary ingredient that enables programs of corrective action to be carried forward, minimizing environmental damage and risk. This status report updates EPA's 10 laboratory research programs dealing with asbestos and related asbestiforms.

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Asbestos/Asbestiform Research in EPA ORD

This report was developed by the Center for Environmental Research Information, Office of Research and Development, U.S. Environmental Protection Agency Cincinnati, Ohio 45268

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FOREWORD

The Office of Research and Development supports the Environmental Protection Agency's mission of protecting the environment and human health by providing a wide range of research and development support to the regulatory standard setting and enforcement functions of the agency. The research and development program is to provide: 1) cost-effective pollution control technology alternatives and incentives; 2) scientific data and information needed to determine health and environmental criteria; 3) measurement methods and agency-wide quality assurance techniques; 4) technological bases requried to develop environmental control standards; and 5) approaches to balancing environmental management options in the context of competing national needs.

The EPA asbestos/asbestiform research program encompasses a wide range of activity directed toward the control and management of mining, milling, processing, fabricating, and end uses of asbestos. Widespread applications of asbestos in the past have exposed large segments of the population to unknown risks. Research should provide valuable answers to numerous questions related to the use of and the exposure to asbestiform minerals. Access to state-of-the-art research information is a necessary ingredient that enables programs of corrective action to be carried forward, minimizing environmental damage and risk.

The Interagency Regulatory Liaison Group (IRLG) signed an interagency agreement to improve public health through information exchange and to reduce waste and duplication in government. The IRLG consists of the Department of Agriculture, Consumer Product Safety Commission, Environmental Protection Agency, Food and Drug Administration and Occupational Safety and Health Administration. These agencies have established a cooperative endeavor to protect the public from exposure to harmful levels of toxic substances by the sharing of information and the development of consistent regulatory policy (toxic substances can result from the use of consumer products, food and drugs in the workplace, or from exposure in contaminants in land, air, or water). This report is intended to update EPA's laboratory research programs dealing with asbestos and related asbestiform minerals.

Carl Schafer
Director
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Office of Environmental Engineering
and Technology

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INTRODUCTION

Asbestos, a natural mineral fiber, is a carcinogen found in air, water, and food, in varying amounts in all parts of the United States. Besides the natural release of asbestos-bearing formations into the environment from wind and water erosion, there are man-made emissions from: mining and milling asbestos ores; consumptive use through the manufacture of asbestos products; the wearing or consumption of asbestos-containing products; asbestos incidental to industrial or commercial processes; and release from structures during renovation or demolition. Exposure to asbestos fibers may occur throughout urban environments, both in drinking water supplies and in the ambient air.

The association of impaired human health with industrial exposure to asbestos is well known. Asbestosis (fibrosis of the lung) and pulmonary cancer are associated with the mining and milling of asbestos and the manufacture and use of asbestos products. On the other hand, the effects of the ingestion of asbestos have not been firmly established.

There is a need to define the various sources from which asbestos and asbestos-like minerals enter the environment, to establish subsequent health and environmental effects, and to examine possible control strategies that will offer current regulatory alternatives.

In response to this need, the Office of Research and Development (ORD) is active in several areas of laboratory research. The following laboratories are involved in these asbestos-related research projects:

- Industrial Environmental Research Laboratory - Cincinnati (IERL-CI)
- Municipal Environmental Research Laboratory - Cincinnati (MERL-CI)
- Environmental Monitoring Systems Laboratory - Research Triangle Park (EMSL-RTP)
- Environmental Monitoring Systems Laboratory - Las Vegas (EMSL-LV)
- Health Effects Research Laboratory - Cincinnati (HERL-CI)
- Health Effects Research Laboratory - Research Triangle Park (HERL-RTP)
- Environmental Research Laboratory - Duluth (ERL-DU)
- Environmental Sciences Research Laboratory - Research Triangle Park (ESRL - RTP)
- Environmental Research Laboratory - Athens (ERL-ATH)
- Environmental Research Laboratory - Gulf Breeze (ERL-GB)

The research encompasses: 1) control, removal, and disposal technologies; 2) monitoring and sampling techniques; 3) health effects; and 4) identification and measurement techniques.

Efforts are focused on the development of technologies for the safe and effective control, removal, and disposal of asbestos in both industrial and public buildings (IERL - CI). The application of various treatment techniques for filtration of asbestos fibers in public water supply systems and the coating of asbestos-containing materials to prevent the entrance of asbestos into air and water are also being studied (MERL-CI). The development of these technologies will minimize human exposure to asbestos and asbestos-containing materials.

Extensive air monitoring and sampling is conducted to develop an asbestos standard, support revisions of already-existing standards (EMSL-RTP), and respond to emergency requests for information (EMSL-LV).

Cooperative *in vivo* and *in vitro* studies, and mineralogical analyses are used to develop a predictive model for the analysis of asbestos-like minerals (HERL-RTP, ERL-DU). Epidemological studies of occupational and non-occupational exposure are also being conducted. The results of these studies can provide health effects data useful for evaluating the risk of human exposure to asbestiform minerals.

Epidemiological, animal, and cell culture studies are conducted in order to examine the health effects of drinking water containing asbestos (HERL-CI). The accumulation of mineral fibers in aquatic organisms is also studied to extend the methodology for identifying and characterizing asbestos and asbestos-like fibers in tissue (ERL-DU, ERL-GB).

Research is continuing for the development and improvement of standard measurement methods of using the electron microscope in the analysis of both inhaled (ESRL-RTP) and ingested (ERL-ATH) asbestos fibers. Research is also being directed toward the development of non-electron, bulk, rapid, analytical methods that will be less costly and time-consuming, and toward the development of improved preparation and preservation methodology.

This report contains a program overview for each laboratory, and abstracts of the research projects that are presently being conducted or have recently been completed by that laboratory. ORD interagency research projects are also presented.

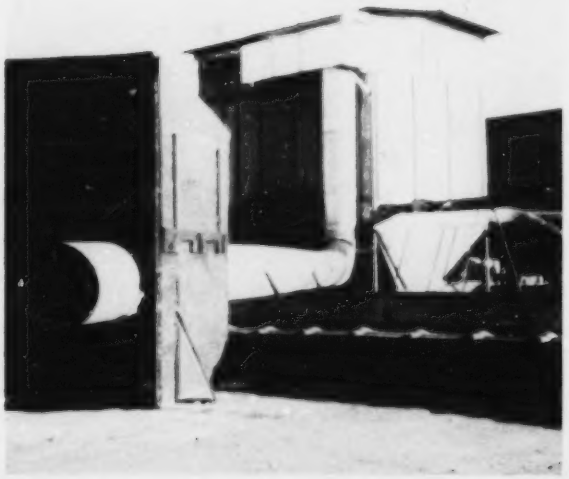
CINCINNATI

INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY

Application of sealant to encapsulate asbestos-ceiling materials

The Industrial Environmental Research Laboratory (IERL) - Cincinnati has been active in defining industrial and building structure environments and examining control technologies in order to minimize human exposure to asbestiform materials. The IERL asbestos-asbestiform research program encompasses both the industrial and private sectors. The industrial portion of the research program addresses mining, manufacturing, application, use, and disposal. There is a plan to coordinate a portion of the public sector's air interagency research under the National Research Program on Indoor Air Pollution.

Friable asbestos, used in construction for insulation and sound-deadening purposes, can release small asbestos fibers into indoor air and



Baghouse for asbestos removal showing plenum, ducting, and effluent sampling station

Vacuum system for removal and disposal of asbestos

is already recognized as a possible health problem in schools and other buildings. The small fibers remain airborne for long periods and can be inhaled into the lungs of building occupants. Strong evidence of increased incidence of lung cancer among people known to have breathed asbestos dust has caused EPA to issue a Notice of Rulemaking concerning control action for friable asbestos in schools.

Extensive work is in progress on the evaluation of sealants that will prevent harmful emissions of asbestos fibers from spray-on coatings. IERL is continuing research in optimal methods for the control, removal, and disposal of friable asbestos utilizing chemical stabilizers, baghouses, and vacuum systems.

In addition, IERL has become involved in the development and presentation of audio-visual materials and a series of seminars to inform regional administrators and public school districts about the asbestos public sector problems.

Project Title: CHEMICAL STABILIZERS FOR THE CONTROL OF FUGITIVE ASBESTOS EMISSIONS

Starting Date: September, 1978

Ending Date: January, 1981

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Performing Organization: IIT Research Institute
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Investigators: P.K. Ase, K. Gutfreund, R. Purcell, N. Rajendran, D. Walia, G. Yamate, E. Luebcke, R. Norman
Tel. (312) 567-4287

Abstract: The objective of this project is to evaluate the effectiveness of chemical stabilizers for reducing asbestos emissions from waste dumps and for reducing asbestos emissions from crushed rock prepared from asbestos serpentinite. A large number of chemical stabilizing agents are currently being promoted as fugitive dust control agents. This program will assess the effectiveness and suitability of these agents for emission control of asbestos waste piles and unpaved roadways made from crushed serpentinite rock containing asbestos. A wind tunnel will be used to assess chemicals employed for stabilization.

This project approach utilized basic laboratory evaluations of commercial stabilizers for further study. Wind tunnel tests will assess the levels of asbestos emissions after samples have been treated with the chemical and then submitted to accelerated weathering through many heat/cold/rain cycles.

Collection of asbestos waste samples and laboratory evaluations of chemical stabilizers has already been completed. Effectiveness of chemicals for fugitive asbestos fiber control from unpaved roads will be assessed in a field test carried out on a stretch of a serpentinite rock-surfaced road. Field testing of unpaved roadway in Harford County of Maryland, near the Pennsylvania border, is underway and will be completed in 1980.

IERL-CI

Project Title: OPTIMIZING BAGHOUSE PERFORMANCE TO CONTROL ASBESTOS

Starting Date: March, 1977

Ending Date: September, 1979

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Investigator: D. Jones, Chemistry Research Division
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Abstract: Fabric filters (baghouses) have been found to be the most effective method of controlling asbestos emissions from manufacturing processes. In asbestos mining, small fabric filters are used for control during drilling. Cyclones, bag collectors, and properly designed ducts are then used for dust control in the crushing operation. Cyclones, sometimes followed by baghouses, are used as control devices on dryers.

The objective of this IERL project was to demonstrate under actual plant conditions several-fold improvements in baghouse collection efficiency by optimizing the operating parameters.

The project involved: 1) development of an experimental test plan; 2) modifications to the baghouse demonstration unit at an asbestos products plant; and 3) full-scale field demonstration.

The results from the study prove that: the single most important variable in the level of fiber emissions from a baghouse is the duration of the shake-time for the bags during the cleaning operation; and the next variables of importance are the amplitude of the shake, and the shake period.

These three variables account for about 40% of output variability from the baghouse which is specific to the concentration of asbestos fibers in the air after baghouse. The interactions between the three parameters of shake period, shake amplitude, and shake time are important in establishing the optimized combination of conditions for baghouse performance. The lowest concentration of asbestos fibers in air was achieved when operating at: short shake, small shake amplitude, and long shake period.

IERL-CI

Project Title: EVALUATION OF SEALANTS FOR SPRAY-ON ASBESTOS-CONTAINING MATERIAL IN BUILDINGS

Starting Date: August, 1977

Ending Date: March, 1979

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Investigator: W. Mirick, Columbus Laboratories
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Abstract: Many public buildings have been sprayed with asbestos fiber coatings. Now that it is recognized that asbestos is carcinogenic, an effort is being made to find sealants that will prevent harmful emissions from these coatings. The purpose of this research is to find suitable sealants and to establish procedures for their application. In addition, under interagency agreement, IERL participates in seminars and provides audio visual materials to acquaint school building engineers and administrators with corrective action options for friable asbestos problems.

A preliminary study indicated that asbestos from a sprayed-on asbestos-containing material can enter the ambient atmosphere when the sprayed-on material begins to deteriorate by vibration and air movement, by accidental impact of various objects against the material, and by removal of the material.

The first objective of this IERL study was to evaluate commercially available sealants which can be used to cover sprayed-on asbestos-containing materials in buildings and which will inhibit the release of asbestos fibers into the ambient atmosphere. Each sealant selected underwent a variety of laboratory tests to determine suitability. These tests included compatibility of sealant and asbestos

material, penetration, flexibility, impact and abrasion resistance, flammability, and toxicity.

A second objective in this study was a field evaluation of at least four sealants. A site was selected with sprayed-on asbestos-containing material on the ceiling. Each of the four sealants selected on the basis of the above test results was sprayed on a test area and evaluated.

The third objective of this study was to measure the asbestos fiber count in the air in order to characterize the effect of the field tested sealants. Samples were taken several times, before, during, and after application of sealant. Analysis was done by electron microscopy.

IERL-CI

Project Title: PREPARATION OF FIFTEEN STATUS ASSESSMENT REPORTS

Starting Date: February, 1978

Ending Date: September, 1978

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Performing Organization: Monsanto Research Corporation
1515 Nicholas Road, Box 8
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Investigators: T.R. Blackwood, W.H. Hedley
Tel. (513) 268-3411

Abstract: This project was conducted to review and rewrite status assessment reports submitted by EPA, in the established format of Office of Research and Development reports. The reports were each reviewed by a chemical specialist, technical editor, and format editor. Additional information, when available, will be added by engineers assigned to the project. Subjects of the assessments are acrylonitrile, arsenic, benzene, benzidine, hexachlorobenzene, polybrominated biphenyls, polynuclear aromatics, trichloroethylene, TRIS, vinylidene chloride, cadmium, lead, phosphates, mercury, and asbestos.

Information was primarily obtained from open literature sources including government reports. The report was published in, Archer, S.R., Blackwood, T.R., "Status Assessment of Toxic Chemicals: Asbestos." EPA 600/2-79-200, December, 1979.

Project Title: EVALUATION OF A COMMERCIAL VACUUM SYSTEM FOR THE REMOVAL OF ASBESTOS

Starting Date: October, 1979

Ending Date: February, 1980

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Tel. (312) 567-4288

Abstract:

Personal, area, and environmental asbestos exposures resulting from wet and dry asbestos removal using a commercial vacuum system were measured in a brief field study. Personal and area (indoor) asbestos concentrations during dry removal were less than one fiber per cm^3, as measured by NIOSH P&CAM 239, when the vacuum system was used. Asbestos released to the environment from the vacuum system's three-stage exhaust filter was negligible. Asbestos was released from the system operator's protective garments when he exited the work area to service the vacuum system.

Sources of asbestos fiber release associated with vacuum system operation were identified; these occurred during operation disassembly and asbestos disposal. Following vacuum shutdown, liquid drained out of the collection reservoir due to inadequate door seals. During vacuum hose disassembly, bulk losses of asbestos-containing materials occurred. During disposal, the exterior of the vacuum truck became contaminated as the reservoir was emptied. The need for additional dry removal testing has been clearly identified.

The results of this research are summarized in, Welker, R.W., Finn, D.F., Stockham, J.D., and Hancock, R.P., "Evaluation of a Commercial Vacuum System for the Removal of Asbestos." EPA-600/2-80-088, May 1980.

Asbestos in rock formation

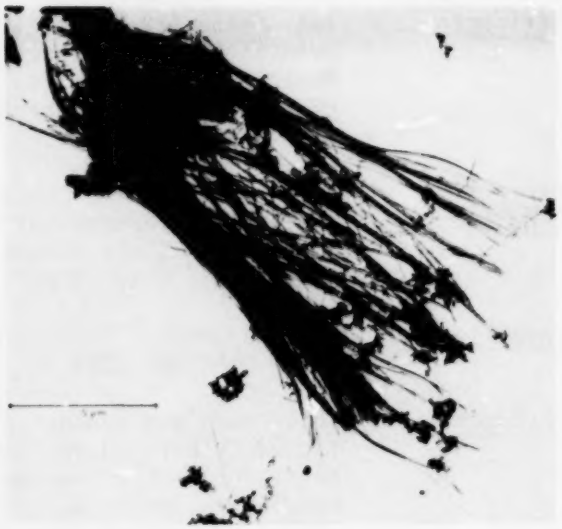
MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY

The Municipal Environmental Research Laboratory (MERL) - Cincinnati has been conducting research to provide more detailed knowledge about water filtration for asbestos removal.

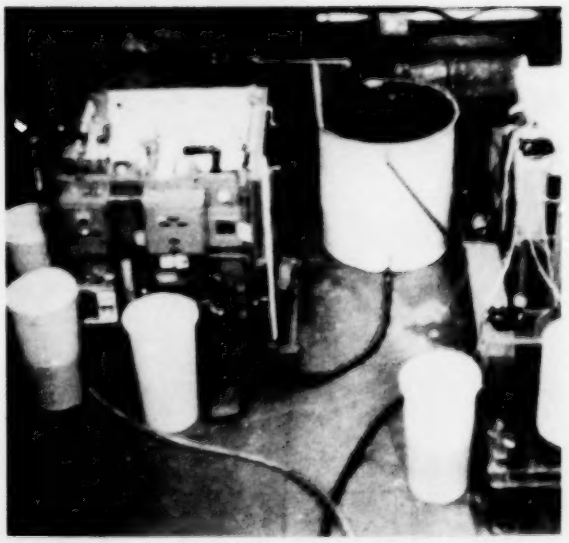
Data on asbestos removal have been collected from filtration plants in Duluth, Minnesota and Seattle, Washington. The results show that chrysotile and amphibole fiber concentrations in drinking water can be substantially reduced by granular media filtration. Effective granular media filtration required very diligent plant operation with careful control of pH, coagulant doses, and filtered water turbidity. Extensive monitoring programs have been conducted in Philadelphia and the San Francisco Bay area. These studies confirm earlier work showing that large water filtration plants remove asbestos fibers.

In addition, MERL has been studying the attack on asbestos-cement pipe (A/C) by aggressive water. A test system was developed, using a 100-gallon stainless steel tank equipped with a floating cover to eliminate atmospheric effects on water quality. Water is recirculated past an A/C pipe coupon about 1-1/2 inches wide and 6 inches long, for up to six months. This research showed that corrosion control additives containing zinc protect A/C pipe. It was also found that increasing the hardness and pH of the water, so that calcium carbonate is precipitated, also results in protection of the A/C pipe.

A current goal of the corrosion control research is to find treatment chemicals that can protect A/C pipe in the distribution system, as well as one or more of the types of metal pipe that might be found in service lines and the customer's plumbing.



Asbestos-cement pipe fibers



Water treatment pilot plant — Duluth, Minnesota (20 gal/min)

MERL-CI

Project Title: REMOVAL OF ASBESTOS FIBERS FROM DRINKING WATER

Starting Date: September, 1978

Ending Date: October, 1979

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Investigator: G.S. Logsdon
Tel. (513) 684-7345

Abstract: This study was conducted to evaluate removal of asbestos fibers by both conventional and direct filtration (no sedimentation) water treatment plants and to prepare a comprehensive report on water filtration for asbestos fiber removal using data from Duluth and other Lake Superior communities; Philadelphia, Pennsylvania; Seattle, Washington; and the San Francisco Bay area.

Study factors included treatment chemicals used, use of flocculation, and rate of filtration to determine effective treatment methods. Filtered water turbidity measurements, filtered water fiber counts, and treatment process controls were related so that filter plant operators could use turbidity data to operate their plants for effective fiber removal. For the most effective reduction of fiber content, the filtered water turbidity should be 0.10 ntu or lower.

The final report was published in G.S. Logsdon, "Water Filtration for Asbestos Fiber Removal." EPA-600/2-79-206, December, 1979.

Project Title: ANALYSIS OF WATER SAMPLES TO DETERMINE CONCENTRATION OF ASBESTOS FIBERS IN DRINKING WATER

Starting Date: May, 1979

Ending Date: December, 1980

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Seattle, Washington 98105

Investigator: E.S. Boatman, Department of Environmental Health
Tel. (206) 543-1144

Abstract: This project is being conducted to determine if a problem exists with amphibole and chrysotile asbestos fibers in the drinking water of Philadelphia, Pennsylvania. Raw and finished water samples will be collected and analyzed for asbestos by electron microscopy methods.

This study and earlier work show that large, conventional water filtration plants remove asbestos fibers. Filtered water typically has fiber counts below detectable limits or not statistically significant. Raw water fiber counts are generally 1 to 10 million fibers per liter.

MERL-CI

Project Title: STUDY OF EROSION OF ASBESTOS FROM ASBESTOS CEMENT PIPE DRINKING WATER SUPPLY

Starting Date: October, 1977

Ending Date: December, 1983

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Investigators: G.S. Logsdon, M. Schock, R.W. Buelow
Tel. (513) 684-7236

Abstract: A small scale system for evaluating corrosion control techniques to protect asbestos-cement (A/C) pipe has been developed and is being used to test corrosion control additives and strategies. A recirculating system with a 100-gallon tank, a floating cover to prevent atmospheric (CO_2)-induced changes in water quality, a small recirculating pump, and a coupon holder are key features of the test apparatus. Water is circulated past the 1 1/2-inch x 6-inch A/C pipe coupon for up to six months. The coupon is then studied to learn if the water attacked and softened the pipe and exposed fiber bundles.

Protection of A/C pipe using silicates, zinc compounds, and calcium carbonate saturation has been studied. Research is under way to learn if A/C pipe and lead or galvanized pipe can be protected by a single corrosion control additive or by combinations of additives. Computer modeling of water chemistry relationships is used to explain the results observed and to select corrosion control additives likely to be successful for specific situations.

Project Title: SEATTLE TOLT WATER SUPPLY - MIXED ASBESTOS FORMS REMOVAL STUDY

Starting Date: May, 1976

Ending Date: August, 1979

EPA Project Officer: Gary S. Logsdon
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Municipal Environmental Research Laboratory
26 West St. Clair Street
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Performing Organization: Seattle City Water Department
1015 3rd Avenue
Seattle, Washington 98104

Investigator: G.J. Kirmeyer
Tel. (206) 625-4146

Abstract: The objectives of this study were: 1) to determine the most feasible method of removal of naturally occurring mixed amphibole and chrysotile asbestiform fibers from a major source of the Water Supply of the City of Seattle, and 2) to extend the methodology developed in an earlier pilot plant filtration study to include removal of chrysotile by modifications of the filtering technique successfully developed for removal of amphibole fibers.

A relationship was developed between filtered water turbidity and effectiveness of the filtration process.

The final report was published in Kirmeyer, G.J. "Seattle Tolt Water Supply - Mixed Asbestos Forms Removal Study." EPA-600/2-79-125, Appendices B and C, EPA 600/2-79-153, and Appendix D, EPA 600/2-79-126, August, 1979.

MERL-CI

Project Title: ESTIMATING COSTS FOR WATER TREATMENT AS A FUNCTION OF SIZE AND TREATMENT EFFICIENCY

Starting Date: November, 1976

Ending Date: June, 1979

EPA Project Officer: Robert M. Clark
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Cincinnati, Ohio 45268

Performing Organization: Culp/Wesner/Culp
P.O. Box 40
El Dorado Hills, California 95630

Investigators: R.L. Culp, R.C. Gumerman, S.T. Hansen, T. Linick
Tel. (916) 677-1695

Abstract: Three major topic areas were: 1) development of detailed construction, operating, and maintenance cost estimates (developed from contractor-produced designs) for the treatment of drinking water at the average influent flow rates of 1, 10, 100, and 200 mgd; 2) estimation of the costs of treatment technology for small water supply systems where investigations were directed toward technological processes that could provide alternatives to standard processes, but which were particularly appropriate and cost-effective for small water supplies; and 3) estimation of costs for removing specific contaminants (asbestos and virus) from water supplies by modifying standard treatment processes.

The results were published in R.C. Gumerman, R.L. Culp, and S.T. Hansen, "Estimated Water Treatment Costs." EPA-600/2-79-162A (B,C,D), August, 1979.

Project Title: PREPARATION OF SUSPENSION OF ASBESTOS IN WATER SUITABLE FOR USE AS REFERENCE SAMPLES FOR ELECTRON MICROSCOPY

Starting Date: March, 1977

Ending Date: April, 1981

EPA Project Officer: Thomas J. Sorg
Tel. (513) 684-7370; FTS: 684-7370
Drinking Water Research Division
Municipal Environmental Research Laboratory
26 West St. Clair Street
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Performing Organization: U.S. Environmental Protection Agency
Municipal Environmental Research Laboratory
26 West St. Clair Street
Cincinnati, Ohio 45268

Investigators: R. Feldman, P. Clark
Tel. (513) 684-7236

Abstract: This study involved preparation of asbestos suspensions utilizing various asbestos sources to determine the feasibility of their use as reference samples. During the initial phase of this project, a known mass of asbestos was suspended in a detergent solution containing $HgCl_2$ preservative. The characteristics of asbestos from at least two sources (synthetic asbestos being prepared under contract and asbestos being used by NIEHS in animal feeding studies) were to be examined to determine which source provides asbestos with the desired characteristics. This asbestos suspension must contain fibers which: 1) can be analyzed by electron diffraction and energy dispersive x-ray fluorescence; 2) have a size distribution like that usually found in water samples; 3) do not clump and appear in preparations as individual fibriles; and 4) contain little foreign material. If satisfactory suspensions can be prepared, they will be sorted in 20 ml sealed ampoules and periodically analyzed to determine if the suspension changes with time. If no significant changes occur in 6 months, then reference samples will be prepared for distribution.

Six different reference asbestos samples have been prepared using different techniques. These turned out to be unsuccessful. However, new samples have been developed and it appears that they will be successful.

MERL-CI

Project Title: EVALUATION OF NATURAL INHIBITING FACTORS IN AN AGGRESSIVE DRINKING WATER SUPPLY

Starting Date: September, 1977

Ending Date: Not available

EPA Project Officer: Gary S. Logsdon
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26 West St. Clair Street
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Performing Organization: University of Massachusetts
Amherst Campus
School of Arts & Sciences
Amherst, Massachusetts 01002

Investigator: O.T. Zajicek, Department of Chemistry
Tel. (413) 545-2627

Abstract: The objective of this project was to determine why the Amherst Water Supply, which has a very aggressive chemical nature, does not severely attack asbestos cement and cast iron pipe.

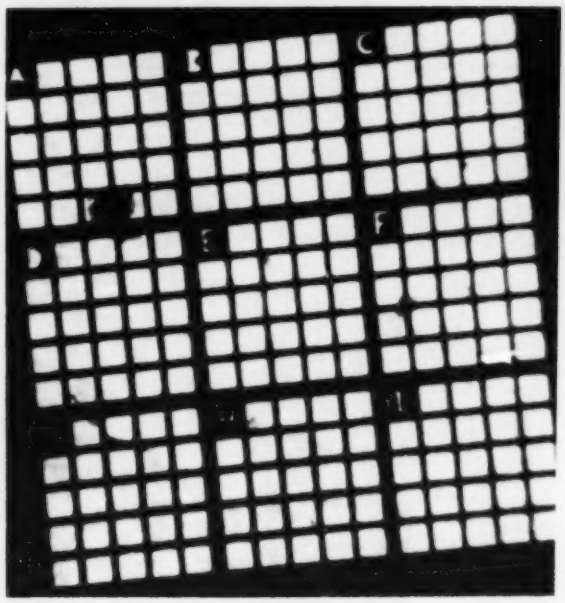
The Amherst water chemical quality was compared to the chemical quality of other water supplies that are known to be aggressive toward water piping materials. The draft of the final report has been submitted.

RESEARCH TRIANGLE PARK

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY

The need to monitor asbestos in ambient air exists because of the difficulty in controlling all sources of asbestos emissions, and it is in the public interest that the effectiveness of the emission controls be assessed. The Environmental Monitoring Systems Laboratory (EMSL) - Research Triangle Park has responsibility for: assessment of environmental monitoring technology and systems; implementation of agency-wide quality assurance programs for air pollution measurement systems; and providing technical support to other groups in the agency including the Office of Air, Noise and Radiation, the Office of Pesticides and Toxic Substances, the Office of Enforcement, and the Office of Air Quality Planning and Standards. Accordingly, EMSL - RTP is engaged in programs to: (1) standardize asbestos measurement techniques; (2) develop asbestos reference materials to support quality assurance activities; and (3) provide technical support to asbestos monitoring efforts currently underway.

Protocols for the measurement of airborne asbestos by transmission electron microscopy, and the measurement of bulk asbestos by polarized light microscopy and x-ray diffraction are now under investigation by EMSL-RTP. Reference materials designed for use in performance testing of asbestos measurements are being developed using characterized asbestos materials and appropriate matrices. The EMSL-RTP program is designed to provide for reliable asbestos measurements which are essential for monitoring this hazardous material.



Transmission electron microscope indexed grid specimen

Collecting fiber-bearing stones from a roadway

EMSL-RTP

Project Title: INVESTIGATION OF CHRYSOTILE ASBESTOS EMISSIONS RESULTING FROM VEHICULAR TRAFFIC

Starting Date: August, 1979

Ending Date: May, 1981

EPA Project Officer: Ronald J. Drago
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Environmental Monitoring Division
Environmental Monitoring Systems Laboratory
Research Triangle Park, North Carolina 27711

Performing Organization: U.S. Environmental Protection Agency
Environmental Monitoring Systems Laboratory
Research Triangle Park, North Carolina 27711

Investigators*: M.E. Beard, Quality Assurance Division
Tel. (919) 541-2623; FTS: 629-2623
B. Martin, R. Highsmith, Environmental Monitoring Division
Tel. (919) 541-3075; FTS: 629-3075

Abstract: A program is underway to measure emissions from roadways surfaced with crushed stone containing small amounts of asbestos. Sites in northeast Maryland and California were selected for study. Roads with aged surfaces or freshly surfaced with crushed stone were selected for study. Areas where ground surface and roadways contain high concentrations of asbestos were selected in the Clear Creek Recreation Area in California. Particulate samplers were placed at upwind and downwind sites near the roadways and road surface material samples were collected with each air sample. Vehicular traffic was controlled during sampling and appropriate meteorologic data was collected.

Samples are now being analyzed for asbestos using the EPA provisional electron microscopic method. This work is being conducted for the Office of Air Quality Planning Standards.

*Several EPA personnel and service contractors are involved in this study. For specific information contact M.E. Beard.

Project Title: DEVELOP METHOD WRITE-UP AND CONDUCT ROUND-ROBIN TEST FOR MEASUREMENT OF BULK ASBESTOS BY POLARIZED LIGHT MICROSCOPY AND X-RAY DIFFRACTION

Starting Date: October, 1979

Ending Date: June, 1980

EPA Project Officer: Michael E. Beard
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Quality Assurance Division
Environmental Monitoring Systems Laboratory
Research Triangle Park, North Carolina 27711

Performing Organization: Research Triangle Institute
Systems and Measurements Division
Environmental Measurements Department
Research Triangle Park, North Carolina 27709

Investigator: D.E. Lentzen
Tel. (919) 541-6745

Abstract: Protocols describing the analysis of bulk asbestos samples by polarized light microscopy (PLM) and x-ray diffraction have been developed from information presented by several investigators at a workshop held by EPA and The Bureau of Mines at Avondale, Maryland in October, 1979. The protocols were subjected to a round-robin test to determine estimates of their precision and accuracy.

The test showed that the PLM protocol with a point count procedure produces data less biased and more precise than other PLM procedures currently used by the analysts. A model relating PLM aerial estimates of asbestos concentration to mass estimates was developed and tested. Results of the investigation are being prepared for publication. The methods are to be used in surveys of schools for asbestos hazards by the Office of Pesticides and Toxic Substances.

EMSL-RTP

Project Title: EVALUATION AND COLLABORATIVE TESTING OF THE PROVISIONAL METHOD FOR MEASUREMENT OF AIRBORNE ASBESTOS

Starting Date: September, 1979

Ending Date: March, 1981

EPA Project Officer*: Michael E. Beard
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Quality Assurance Division
Environmental Monitoring Systems Laboratory
Research Triangle Park, North Carolina 27711

Performing Organization: IIT Research Institute
10 West 35th Street
Chicago, Illinois 60616

Investigator: G. Yamate
Tel. (312) 567-4295

Abstract: An evaluation of various measurement techniques for airborne asbestos described in EPA report 600/2-78-038 resulted in the development of an optimized analysis protocol described in EPA Report 600/2-77-178 as the provisional method for measurement of airborne asbestos. Further investigation designed to evaluate and optimize several key operations described in the method is now in progress.

The provisional method describes particulate collection on (or transfer to) polycarbonate film filters which are carbon coated, transferred to 3 mm microscope grids using the Jaffe Wick technique, and examined by transmission electron microscopy. Fibers with an aspect ratio of 3:1 (length to width) or greater are identified by morphology, and confirmed by selected area electron diffraction and energy dispersive x-ray fluorescence analysis. Mass is calculated based on volume of the fiber and density of the asbestos variety. Both fiber count and mass are reported for the sample.

The current investigation will focus on determination of optimum face velocity for samplers, effect of transportation on sample, fiber collection efficiency, effect of ashing sample, the development of improved sampling technique using cellulose ester filters, and computer programmed x-ray fluorescence analysis of fibers. The method will be

subjected to a multi-laboratory collaborative test to determine inter- and intra-laboratory precision and accuracy.

*See also Evaluation of Electron Microscope Methods for Measurement of Airborne Asbestos Concentrations and Evolvement of an Optimal Procedure, ESRL - Research Triangle Park, J. Wagman.

EMSL-RTP

Project Title: STANDARD REFERENCE MATERIAL FOR ASBESTOS IN AIR

Starting Date: July, 1979

Ending Date: July, 1981

EPA Project Officer*: Michael E. Beard
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Performing Organization: U.S. Department of Commerce
National Bureau of Standards
Washington, DC 20234

Investigator: J. Small, E. Steel
Tel. (301) 921-2875

Abstract: The National Bureau of Standards (NBS) is engaged in a program to develop reference materials to support quality assurance activities for asbestos measurements made with the EPA provisional method (transmission electron microscopy).

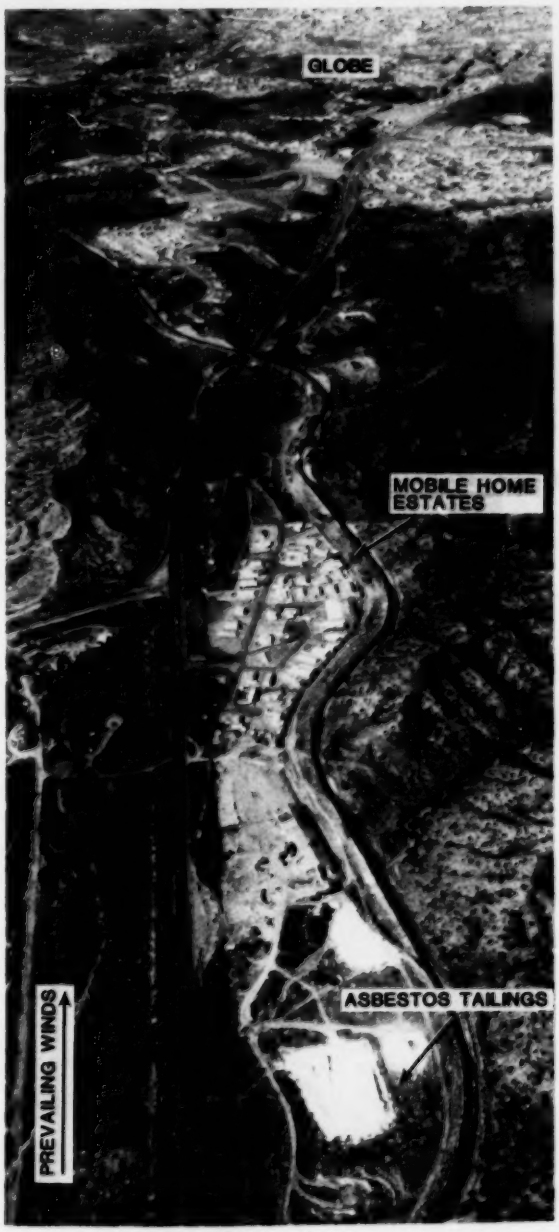
The reference materials will consist of: 1) filters and 2) prepared microscope grids containing characterized samples of chrysotile and amphibole asbestos fibers incorporated in an urban air particulate matrix. These materials will allow the separation of errors due to sample preparation and sample counting. Critical factors related to the analysis of asbestos with the provisional method will be evaluated by NBS and coordinated studies conducted by IIT Research Institute. A workshop on preparation of asbestos standards will be held at NBS. Analysts will address characterization of materials used for standard preparation, sample matrices, and criteria for counting and identifying asbestos fibers. A synopsis of the workshop will be published.

*This study is conducted in conjunction with the National Bureau of Standards. See also, Standard Reference Materials for Asbestos in Air, Interagency - National Bureau of Standards, J. Small.

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY

The Environmental Monitoring Systems Laboratory (EMSL) - Las Vegas is responsible for developing monitoring capabilities, providing quick-response support in emergency environmental situations, and conducting quality assurance analyses. The laboratory became involved in the asbestos issue when the Governor of Arizona requested EPA assistance in evaluating plans for control and cleanup of active and abandoned asbestos mine tailings in and near the city of Globe, Arizona, (approximately seventy miles east of Phoenix). Evacuation orders for homes built within three miles of tailing piles became necessary because of asbestos contamination found in the sewer system. Clean-up orders were issued to asbestos mining operations. Soil samples collected in Globe by Arizona officials indicated high levels of asbestos, but the extent of contaminant transport by winds and surface run-off was not known.

EPA Region IX and the Oil and Special Materials Control Division of the Office of Water Programs Operations requested EMSL-Las Vegas support to obtain multi-altitude aerial photography of the Globe area and the neighboring town of Miami, to describe and evaluate mining operations. EMSL-Las Vegas arranged a photographic overflight on Sunday, December 30th. The photo coverage did not provide desired information for locating the extent of asbestos tailings that are transported by winds, due to excessive rainfall and moisture on the ground. Therefore, experimental overflights were conducted with the hope of tracking asbestos migration. EPA and Arizona health officials are awaiting test results before determining appropriate decontamination procedures for the Globe-Miami area.



Aerial view of asbestos tailings, Globe, Arizona

EMSL-LV is also conducting an analyses of current and archival aerial photography to provide additional information on past operational practices.

EMSL-LV

Project Title: SURVEILLANCE OF ASBESTOS TAILINGS AND PROJECT 8040

Starting Date: December, 1979

Ending Date: September, 1980

EPA Project Officer:
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Performing Organization:
U.S. Environmental Protection Agency
Advanced Monitoring Systems Division
Environmental Monitoring Systems Laboratory
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Las Vegas, Nevada 89114

Investigator:
C.E. Lake
Tel. (702) 798-2100

Abstract:

This study is an experimental program for assisting in the location of asbestos transported by winds and surface run-off, and of active and abandoned asbestos mine tailings. Some of the asbestos sites are located near schools and populated areas of Globe, Arizona.

Experimental overflights, using the multi-spectral scanner and a detector sensitive between 2.0 and 2.5 microns, were conducted during predawn and postdawn hours on May 25 and June 6, 1980. Soil samples from selected areas have been collected by the state and are presently being analyzed for contamination levels. The results from the soil sample analysis will be compiled with the multispectral data, and computer-enhanced in an attempt to produce a quantitative base map that will identify surface levels of asbestos.

Project 8040, which involves the photo analyses of current and archival aerial photography, has been included with the experiment and will provide historical information and documentation of the operational practices that dated between 1940 and 1980.

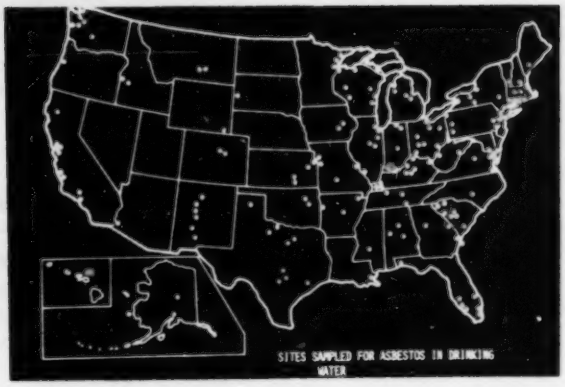
CINCINNATI

HEALTH EFFECTS RESEARCH LABORATORY

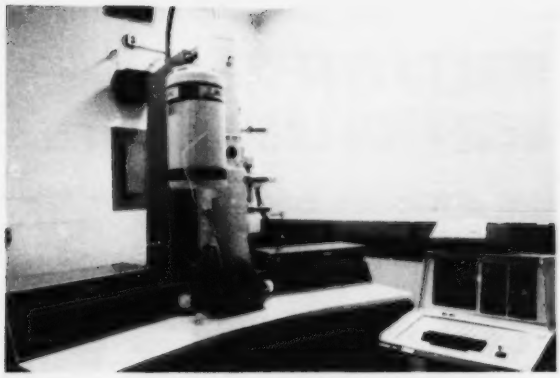
Work on asbestos at the Health Effects Research Laboratory (HERL) - Cincinnati falls under the general work plan heading of "determine health effects information on inorganic constituents in drinking water not currently regulated." Tasks have been developed to investigate the effect on health of drinking water containing asbestos, through epidemiology, toxicology, and cell culture assay.

Epidemiology studies have been initiated in areas where people have been exposed to asbestos in their water from natural erosion or the degradation of asbestos-cement pipe. The variables of asbestos concentration, type, and size will be investigated. The analytical techniques for water and urine analysis used to find exposed populations and assess the extent of exposure are being tested.

Asbestos in corroded asbestos-cement pipe (magnified 500 times)



Sites sampled for asbestos in drinking water



Electron microscope and energy-dispersive X-ray analysis

Animal studies are performed to determine which organs or sites within the body should be considered targets for fiber migration and to determine the rate of accumulation and size of fibers in tissue from exposure through ingestion. The effects of long-term water leaching, and leaching by stomach acid or chrysotile asbestos, will be investigated as they relate to the interpretation of animal data.

Cell culture tests with asbestos are used to study the effects of different sized asbestos and the effect of multiple stress, i.e. synergism between asbestos and organic chemicals.

Project Title: *IN VITRO* ANALYSES OF BIOLOGICAL ACTIVITY OF PARTICULATE SAMPLES

Starting Date: June, 1979

Ending Date: September, 1979

EPA Project Officer: James R. Millette
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Epidemiology Division
Health Effects Research Laboratory
26 West St. Clair Street
Cincinnati, Ohio 45268

Performing Organization: National Center for Toxicological Research
Highway 65 North
Pine Bluff, Arkansas

Investigator: R. Hart, Department of Radiology
Tel. (501) 541-4000

Abstract: The effects of particulates collected from municipal water systems (drinking water) on mammalian cell lines were compared with the effects caused by commercial asbestos materials.

The effects of the materials were tested on the biological endpoints of cytotoxicity; enhancement of virally directed cellular transformation; and alteration of cell membrane, cyclic nucleotides, and DNA. Embryonic cultures were used to compare the effects of five asbestos materials on a cellular, biochemical, and molecular basis.

Chrysotile was found to be the most cytotoxic of the asbestos materials, followed by crocidolite, tremolite, amosite, and silica. Results of tests involving cellular ratios of cyclic nucleotides were consistent, with asbestos acting as a promoter of carcinogenesis. Washed asbestos fibers had little or no effect on induction of DNA damage based on unscheduled DNA synthesis tests. The research is summarized in Hart, R.W., Fertel, R., Newman, U.A.I, Daniel, F.B, and Blakeslee, J.R., "The Effects of Selected Asbestos Fibers on Cellular and Molecular Parameters." EPA-600/1-79-021, 1979. The final report on particulates will be available as a Project Report from NTIS or the project officer.

HERL-CI

Project Title: ASBESTOS AND GASTROINTESTINAL CANCER - CELL CULTURE STUDIES

Starting Date: January, 1976

Ending Date: January, 1979

EPA Project Officer: James R. Millette
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Performing Organization: Naylor Dana Institute for Disease Prevention
1 Dana Road
Valhalla, New York 10595

Investigators: B. Reiss, G.M. Williams
Tel. (914) 592-2600

Abstract: *In vitro* techniques for the delineation of the effects of asbestos on cell types related to the gastrointestinal tract were developed and utilized in this study.

Cytotoxicity was examined on 407 human embryonic intestine-derived and ARL-6 liver-derived cell cultures; mutagenicity assays were also performed. Three forms of asbestos: amosite, crocidolite, and chrysotile were assayed for their cytotoxicity and mutagenicity in cell culture. Using embryonic human intestine-derived and adult rat liver-derived epithelial cells, chrysotile was found to be more toxic than amosite and crocidolite, which were equal in toxicity. Leaching in acid slightly increased the toxicity of amosite and crocidolite and greatly increased the toxicity of chrysotile. High concentrations of all three asbestos forms were not mutagenic in cultures or rat liver-derived epithelial cells.

The results are summarized in ORD publication EPA-600/1-79-023, and in Reiss, B., Soloman, S., Weisburger, J.H., and Williams, O.M., "Comparative Toxicities of Different Forms of Asbestos in a Cell Culture Assay." Envir. Res. 22:109-129 (1980).

Project Title: FATE OF INGESTED CHRYSOTILE ASBESTOS FIBER IN THE NEWBORN BABOON

Starting Date: September, 1977

Ending Date: September, 1979

Project Officer:
James R. Millette
Tel. (513) 684-7462; FTS: 684-7462
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Performing Organization:
University of Illinois
Medical Center at Chicago
School of Public Health
Box 4348
Chicago, Illinois 60680

Investigator:
K.J. Patel-Mandlick
Tel. (312) 996-8855

Abstract:

The objective of this study was to determine the distribution of ingested asbestos fibers in the newborn baboon.

A newborn baboon was orally administered chrysotile asbestos in formula. Ten organs were analyzed for asbestos. Test tissues showed higher levels of asbestos than respective control tissues. The highest concentration of fibers was found in the kidney cortex, followed by lymph nodes, spleen, colon, and esophagus. Fiber size distribution indicated that the largest fibers were retained in the kidney cortex.

The results of the study were published in Patel-Mandlik, K.J., "Distribution of Ingested Asbestos in the Newborn Baboon." EPA-600/1-80-022, 1980.

HERL-CI

Project Title: RECOVERY OF ASBESTOS FIBERS FROM BABOON TISSUES

Starting Date: May, 1979

Ending Date: September, 1980

EPA Project Officer: James R. Millette
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Performing Organization: University of Illinois
Medical Center at Chicago
School of Public Health
Box 4348
Chicago, Illinois 60680

Investigator: W.H. Hallenbeck
Tel. (312) 996-8855

Abstract: The objective of this study was to determine fiber size and distribution of ingested asbestos fibers in the lungs, in urine, and in tissues which show the migratory pathway of fibers through the body.

Juvenile baboons were used for control and test. A concentrated suspension of chrysotile and amphibole asbestos of the types found in drinking water was used. Collection of urine and blood was followed by sacrifice of the animals. The following were examined for the presence of fibers: urine, blood, lung, pleura, urinary bladder, pancreas, and peritoneum.

A method for blood analyses has been developed. The animals have been exposed and sacrificed. The tissues have been analyzed and a report is being prepared.

Project Title: PARTICULATE ANALYSIS OF DRINKING WATER SUPPLIES

Starting Date: September, 1977

Ending Date: September, 1979

EPA Project Officer: James R. Millette
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26 West St. Clair Street
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Performing Organization: U.S. Environmental Protection Agency
Epidemiology Division
Health Effects Research Laboratory
26 West St. Clair Street
Cincinnati, Ohio 45268

Investigator: J.R. Millette
Tel. (513) 684-7462

Abstract: The purpose of this research was to accumulate data on the particulates found in drinking water, and develop systems for classification of these particulates.

Results to date include analysis of over 60 samples of drinking water and classification of particulates into fibrous, nonfibrous, crystalline, organic, and asbestos categories. A report differentiating between chrysotile asbestos and two clays, palygorskite and halloysite, has been published in, Millette, J.R., Twyman, J.D., Hansen, E.C., Clark, P.J., and Pansing, M.F., "Chrysotile, Palygorskite, and Halloysite in Drinking Water." Scanning Electron Microscopy I: 579-86 (1979).

HERL-CI

Project Title: ASSESSMENT OF ASBESTOS EXPOSURE TO U.S. PUBLIC FROM DRINKING WATER

Starting Date: June, 1977

Ending Date: June, 1980

EPA Project Officer:
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Performing Organization:
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Epidemiology Division
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26 West St. Clair Street
Cincinnati, Ohio 45268

Investigator:
J.R. Millette
Tel. (513) 684-7462

Abstract:

Over 1,500 asbestos analyses of water supplies in 43 states, Puerto Rico, and the District of Columbia were evaluated in order to assess the exposure of the United States population to asbestos in drinking water.

It was concluded that the large majority of U.S. water consumers are not exposed to concentrations of asbestos fibers above one million fibers per liter. In a few areas people are exposed to concentrations up to one hundred million fibers per liter. The majority of persons receiving water from asbestos-cement pipe distribution systems are not exposed to significant number of fibers from the pipe. In areas of aggressive water, however, water consumers using asbestos-cement mains may be exposed to high concentrations of fibers.

The results of the evaluation have been published in, Millette, J.R., Clark, P.J., and Pansing, M.F., "Exposure to Asbestos from Drinking Water in the United States." EPA-600/1-79-028, 1979.

Project Title: CANCER INCIDENCE IN RELATION TO ASBESTOS IN DRINKING WATER IN THE PUGET SOUND REGION

Starting Date: April, 1978

Ending Date: May, 1981

EPA Project Officers:

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Performing Organization:

Fred Hutchinson Cancer Research Center
1102 Columbia Street
Seattle, Washington 98104

Investigators:

L. Pollisar, D.B. Thomas, Program in Epidemiology & Biostatistics
Tel. (206) 292-2937
E.S. Boatman, University of Washington
W. Hinds, State Dept. of Social & Health Services

Abstract:

Cancer mortality and incidence data will be used to determine if there is an elevated cancer risk for those persons living in areas of the Puget Sound Region with a high concentration of asbestos in the water supply.

Data to be used will include death certificates, incidence records from a population-based tumor registry, census tabulations, and water analyses. Statistical methods will include calculations of rates and analysis of relative risks. A case-control study will be undertaken.

The preliminary results are reported in, Severson, R.K., "A Study of the Effects of Asbestos in Drinking Water on Cancer Incidence in the Puget Sound Region." M. S. Thesis, University of Washington, Seattle, Washington (1979).

HERL-CI

Project Title: FEASIBILITY ASSESSMENT OF POTENTIAL STUDIES TO DETERMINE HEALTH IMPACT OF FILTERING ASBESTIFORM FIBERS FROM DULUTH MUNICIPAL WATER SUPPLY

Starting Date: July, 1971

Ending Date: September, 1977

EPA Project Officer: Leland J. McCabe
Tel. (513) 684-7211; FTS: 684-7211
Epidemiology Division
Health Effects Research Laboratory
26 West St. Clair Street
Cincinnati, Ohio 45268

Performing Organization: State Department of Health
717 Delaware St. S.E.
Minneapolis, Minnesota 55440

Investigators: L.J. Michienzi, W.R. Lawson
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Abstract: The feasibility of studies was assessed in order to determine the health impact of the new water filtration plant in Duluth, Minnesota, which was designed to filter approximately 90 percent of asbestiform fibers from Duluth water. Since June, 1973, when it was announced that Lake Superior and the Duluth municipal water supply, which is drawn from the lake, contained large numbers of asbestiform fibers, many environmental and human health studies have been performed to better assess the situation and its potential hazards. The new water filtration plant is apparently the primary measure to remove asbestiform fibers already in the source of Duluth's municipal water supply.

The main component of the assessment was the review and analysis of all previous and current water and human health studies related to the presence of asbestiform fibers in Duluth's municipal water supply. This involved review of pertinent scientific literature, communication with appropriate technical experts in environmental health, epidemiology, and medicine, and the development and frequent meeting of a multidisciplinary technical advisory group.

Project Title: COMPARE OCCURRENCE AND LEVELS OF DRINKING WATER CONSTITUENTS AMONG 12 MATCHED PAIRS OF HIGH AND LOW CANCER MORTALITY COUNTIES OF THE USA

Starting Date: September, 1977

Ending Date: June, 1981

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Abstract: The aim of this project is to determine if matched counties with contrasting cancer mortality rates use drinking water that has significantly different characteristics in terms of occurrence and levels of contaminants, treatment technologies used, and/or source type (ground or surface).

Using available data from the National Cancer Institute, all U.S. Metropolitan counties were sorted into categories defined by five parameters: region of the country, population years at risk (females for the time period 1968-1972), percent of population employed in manufacturing industry, percent urbanization, and average educational level. Each pair of counties was selected from categories so that one had a female age-adjusted cancer mortality rate 24 and the other 16, for a total of four sites: colon, rectum, bladder, and liver. Historical data from each county has been collected from the appropriate state regulatory agencies and the major utilities in the counties; data collected are sources and treatment technologies used during the previous 30 years for each served area.

Water samples are being collected bimonthly for analyses for mutagens and biannually for analyses for 41 inorganic chemicals, 6 trihalomethanes, TOC, fluorescence, asbestos, and radiation. Comparisons of water constituent occurrences and levels, treatment technologies, and source types will be made among the pairs of counties to determine if significant differences exist for counties with contrasting cancer mortality rates.

Project Title: ASBESTOS IN DOMESTIC WATER SUPPLIES AND CANCER INCIDENCE IN FIVE CALIFORNIA COUNTIES

Starting Date: April, 1976

Ending Date: December, 1978

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Abstract:

The association between the presence of asbestos fibers in drinking water and the incidence of cancer in the population served by such water supplies was determined.

The study was divided into three overlapping phases. The first phase dealt with the identification and description of San Francisco Bay Area watershed and water distribution systems, which includes: the site of water sources, their geomorphic composition, geo-political area served, method of water treatment, and means of distribution. The second phase was directed towards the determination of number, size, and type of asbestos fibers present in the various water supplies before and after treatment, and after distribution. The third phase involved a tabulation of tumor incidence and cancer mortality data from the third National Cancer Survey, conducted in the five San Francisco Bay Area counties under consideration. Correlations between the observed occurrence of asbestos in drinking water and the incidence of human cancer were determined using the information gathered in the three phases of this study.

The results of this study are published in, Kanarek, M.S., Conforti, P.M., Jackson, L.A., Cooper, R.C., and Murchio, J.C., "Asbestos in Drinking Water and Cancer Incidence in the Bay Area." Am. J. Epidemiology 112:54-72 (1980).

Project Title: EPIDEMIOLOGICAL STUDY BY ASBESTOS EXPOSURE IN CONNECTICUT WATER

Starting Date: September, 1976

Ending Date: September, 1979

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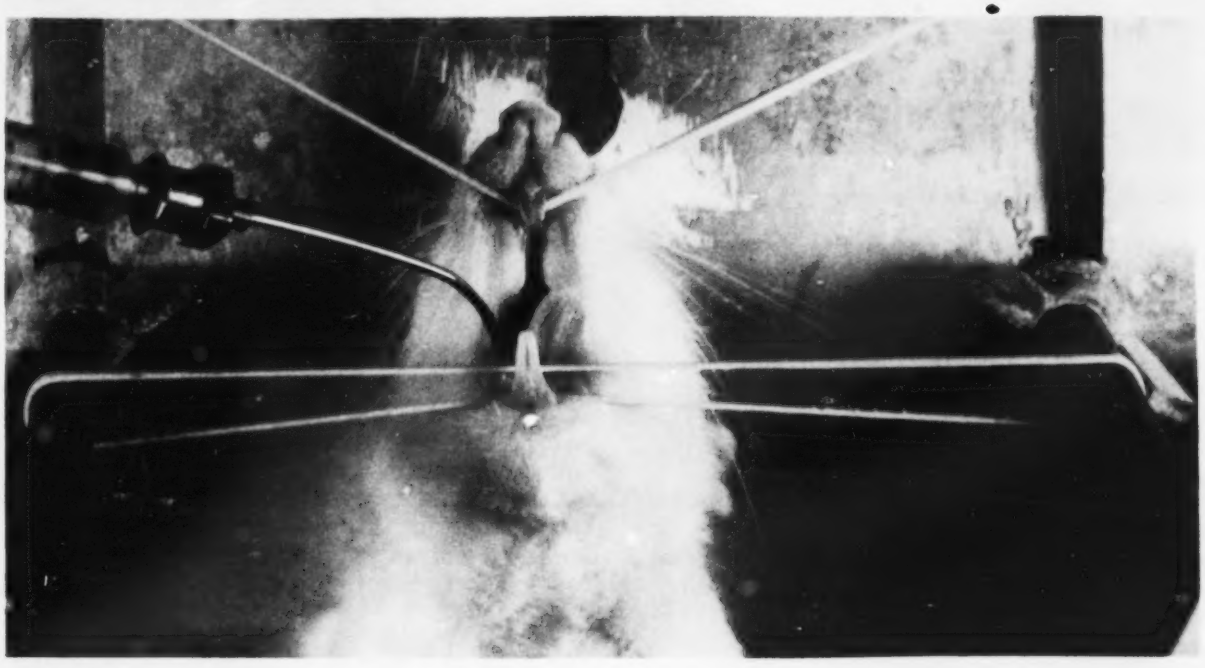
Abstract: This study first provided data to determine the extent of exposure to asbestos that was associated with drinking water from asbestos-cement pipe in Connecticut townships. The age-adjusted sex-specific incidence data for stomach, colon, and rectal cancer for Connecticut townships for the period 1935 to 1973 were then used to investigate whether asbestos cement pipe usage for domestic drinking water was associated with gastrointestinal cancer.

The program of sampling and analysis was designed to furnish data to be used to: 1) validate the relationship between stability index (characterizing the water's aggressiveness), age, and length of asbestos-cement pipe, and concentrations of asbestos fibers found in the drinking water that flowed through the pipe; 2) determine the relationship between asbestos fiber concentrations and cancer; 3) determine the relationship between total large rigid fiber concentrations in drinking water from asbestos-cement pipe and cancer; and 4) determine the relationship, if any, between total large rigid fibers observed by optical microscope and asbestos fibers counted by electron microscope.

The townships were grouped according to the Assessment of Exposure (AOE) and Risk Factor (RF) for asbestos. No association was noticed between these asbestos risk scores and the incidence of gastrointestinal tumors. Results of the study utilizing actual fiber count data from the Connecticut water supplies and a more sophisticated analysis procedure did not show any association. A paper describing the study has been published in, Meigs, J.W., Walter, S.D, Heston, J.F., Millette, J.R., Craun, G.F., Woodhall, R.S., and Flannery, J.T., "Asbestos Cement Pipe and Cancer in Connecticut 1955-1974." J. Environ. Health 42(4) 187-191 (1980).

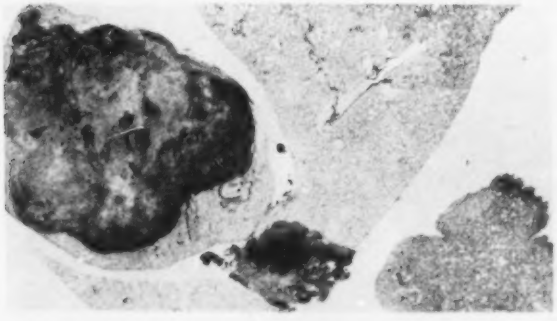
HEALTH EFFECTS RESEARCH LABORATORY

RESEARCH TRIANGLE PARK

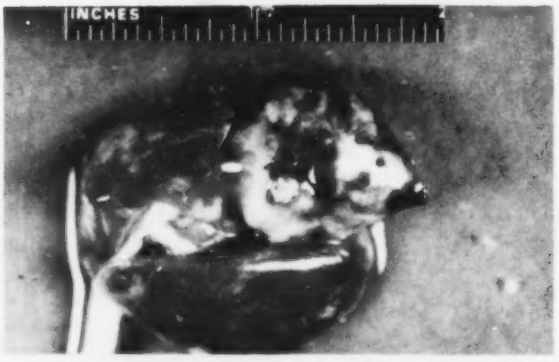


Rat receiving intratracheal injection of amphibole

A large proportion of the surface or near-surface rocks of the continental United States contain various kinds of mineral fibers that are emitted into the air or gain access to water through commercial operations. Many of these fibers resemble commercial asbestos fibers. Due to the widespread natural occurrence of these minerals in many sections of the country, there are few hard rock operations in which there is not some risk of uncovering such material. If all of these operations were controlled on the basis of an analogy to asbestos, the cost and disruption to industry would be staggering. These fibers vary from those



Squamous cell carcinoma of the lung from intratracheal injection of amphibole



Rat lung showing squamous cell carcinoma after intratracheal inoculation

HERL-RTP

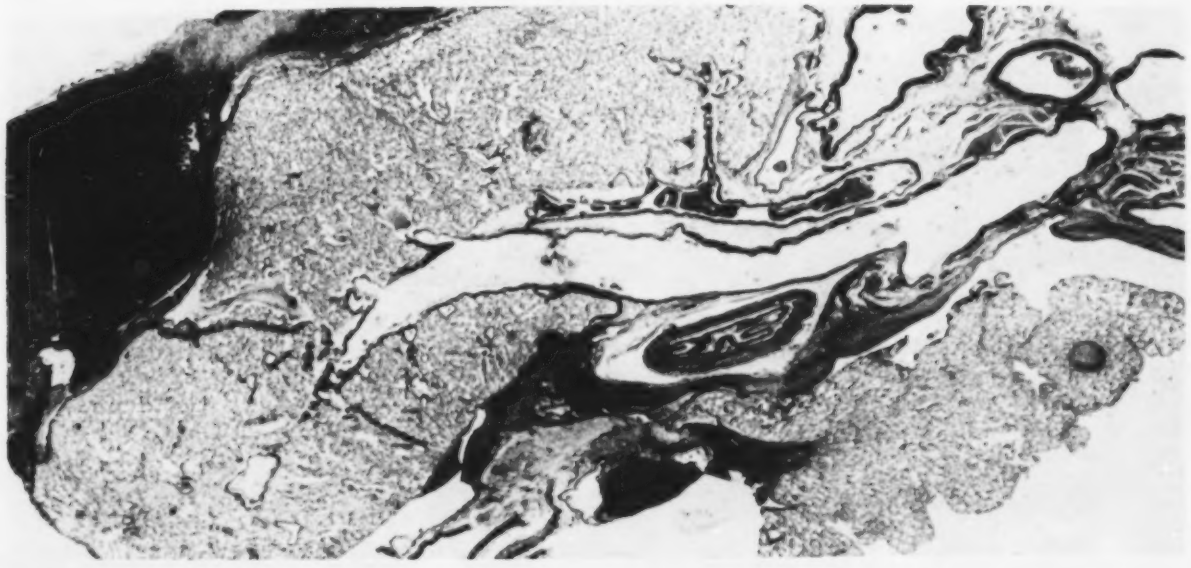
Rat receiving intrapleural injection of amphibole

Rat lung showing mesothelioma after intrapleural injection

almost identical to commercial asbestos, to fibers with little or no physical or chemical resemblance to asbestos types. The Health Effects Research Laboratory (HERL) - Research Triangle Park has conducted a study to provide biological data on which to evaluate the health effects of asbestos-like minerals.

Results expected from these projects may provide data on which to evaluate the risk to employees of the mining industry, estimate the potential for community health problems in areas surrounding mines and ore beneficiation plants, and establish guidelines for continued safe exploitation of essential minerals. Evaluation of the possible health hazard resulting from rock quarrying and crushing, such as the use of crushed rock for road paving, will also benefit from this work. Additionally, information gained from this project, by providing predictive screening systems and basic information concerning dose effect, will help evaluate the problems associated with human exposure to commercial asbestos effluents, sprayed asbestos ceilings, building demolition, solid waste disposal, and other sources of commercial asbestos contamination.

HERL is also conducting epidemiological studies, involving an assessment of mortality rates over a 10 year period, to compare cancer mortality rates in asbestos mining and nonmining counties.



Malignant sarcomatus mesothelioma of the visceral pleura from intrapleural inoculation of amphibole

Project Title: EVALUATION OF HEALTH EFFECTS AND TOXIC POTENTIAL OF NONASBESTOS MINERAL FIBERS

Starting Date: September, 1977

Ending Date: December, 1983

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Abstract: Although exposure to commercial asbestos is a well recognized threat to human health, the risk factor of exposure to other fiber-containing minerals is unclear. It is impractical, however, to test all these minerals by means of classical whole animal models, which have been widely used to investigate the potential health hazards of asbestos samples. It is, therefore, pertinent to develop a less time-consuming system which will determine potential health hazards of nonasbestos minerals with relative ease. The ultimate objective of this cooperative interlaboratory research program is to develop such a predictive model. It is believed that this would be best achieved by first relating mineral properties to tumorigenesis in the animals and then selecting a short term bioassay that will predict the tumorigenicity of the test sample as determined in the animals. This project will produce data which will be also applicable to evaluation of asbestos substitutes.

The following studies are now being conducted: Three amphibole minerals, one a commercial asbestos, are being evaluated for their tumorogenisis by means of lifetime whole animal studies in rats and by various *in vitro* systems. The objective in view is to rank these minerals 1) according to their degree of tumorgenicity by means of intrapleural inoculations and intratracheal instillation, and 2) compare these rankings with data derived from various sub-whole animal tests to

determine which of these compare with the more definitive whole animal methods. The techniques currently applied consist of erythrocyte lysis test, pulmonary macrophage cytotoxicity test, human fibroblast cytotoxicity, and Chinese hamster ovary cell cytotoxicity. Tumor data are available on two of the amphiboles (commercial and noncommercial asbestos). The third is incomplete. These data have been reviewed and diagnostic concensus was achieved by a panel consisting of five pathologists convened under the aegis of the Universities Associated for Research and Education in Pathology. Mesotheliomatous tumors were induced by intrapleural inoculation of both specimens. The mesotheliomas were classified as tubulopapillary, fibrosarcomatous, or pleomorphic sarcomatous and mixed mesothelioma. Lesions derived from intratracheal inoculations were typical bronchoalveolar cell hyperplasia, bronchoalveolar adenocarcinoma, epidermoid carcinoma, tubulopapillary mesothelioma and sarcomatous mesothelioma.

Animal studies completed thus far show that both amphibole samples produce tumors when inoculated intrapleurally -- 22% for the noncommercial asbestos specimens and 29% for the commercial asbestos specimens. A striking reversal was noted, however, from intratracheal instillations where tumor or tumor-like lesions were noted in 5.5% of the noncommercial amphibole and 0.8% for the commercial specimens. These data are being correlated with mineralogical studies to seek an explanation for this striking difference.

*This study is being conducted in collaboration with the Environmental Research Laboratory - Duluth. See also Identify Physical, Morphological, Chemical, and Crystalographic Properties of Fine Particles which Govern their Biological Activity, ERL-Duluth, P. Cook.

Project Title: CANCER MORTALITY IN U.S. CHRYSOTILE ASBESTOS MINING AND NONMINING COUNTIES

Starting Date: October, 1979

Ending Date: May, 1981

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Abstract: This study is a continuation of a pilot study that investigated relative mortality rates of U.S. asbestos mining counties.

The comparison of matched mining and nonmining counties, from the years 1961-1977, indicated that elevated mortality ratios were found at some cancer sites. Elevations of pleural and mediastinal neoplasms were found among white males in the mining counties. Oral and digestive cancer excesses were consistently found among all race/sex groups.

Research is now focusing on the assessment of mortality rates from 1968-1978 using quantitative measures of asbestos exposure in air and water. This will be in collaboration with HERL-Cincinnati and Science Applications, Inc., California.

HERL-RTP

Project Title: STIMULATION OF OXIDANT PRODUCTION IN ALVEOLAR MACROPHAGES BY ASBESTOS

Starting Date: January, 1977

Ending Date: December, 1978

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Abstract: Air pollutant dusts as well as chemically defined particles were examined for their activating effect on oxidant production (O_2 and H_2O_2) in guinea pig alveolar macrophages (AM). Oxidant production in phagocytes appears to be an important mechanism of the body in defense against microbial invasion, and may also be involved in fibrogenesis and inflammatory lung damage.

Oxidant production was measured as chemiluminescence of albumin-bound luminol. Standard UICC asbestos samples stimulated oxidant production upwards of ten-fold higher maximal levels than latex particles. All particles examined stimulated the AM in a dose-dependent manner to different maximal levels of oxidant production at approximately 1 mg/ml of particles. Amphibole asbestos samples (crocidolite, amosite and anthophyllite) were the most active of all agents studied. Zymosan, silica, metal-oxide coated fly ash, polymethyl methacrylate beads, and chrysotile asbestos (A and B) had intermediate activity, while mixed silicate dusts, glass and latex beads, uncoated fly ash and fiberglass had the lowest activity. Asbestos fibers also caused a rapid release of peroxidase from eosinophils which were found to be present in lavage fluid from guinea pigs. In addition to direct stimulatory action on AM, particles also lowered the subsequent

responsiveness of the cells to the bacterial peptide stimulant, F-Met-Phe. This latter effect was only partially due to the cytotoxicity of the particles. Human pulmonary lavage cells from diseased patients were also tested and found to vary widely in their composition of nonmacrophage cells. Human cells also contained peroxidases and could be stimulated by asbestos.

It therefore appears that asbestos and other pollutants which are not easily degraded or removed from the lung could chronically stimulate oxidant production in surrounding phagocytes. Current thinking is that these phagocyte-derived oxidants contribute to inflammatory lung damage and may be involved in fibrogenesis. The results of this research were published in Hatch, G.E., Gardner, D.E., Menzel, D.B., "Stimulation of Oxidant Production in Alveolar Macrophages by Pollutant and Latex Particles." Environ. Research 23, (1980).

Electron micrograph of ferroactinolite fibers recovered from lung tissue of a rat after intratracheal injection (magnified approximately 15,000 X; 1 cm equals 0.67μ)

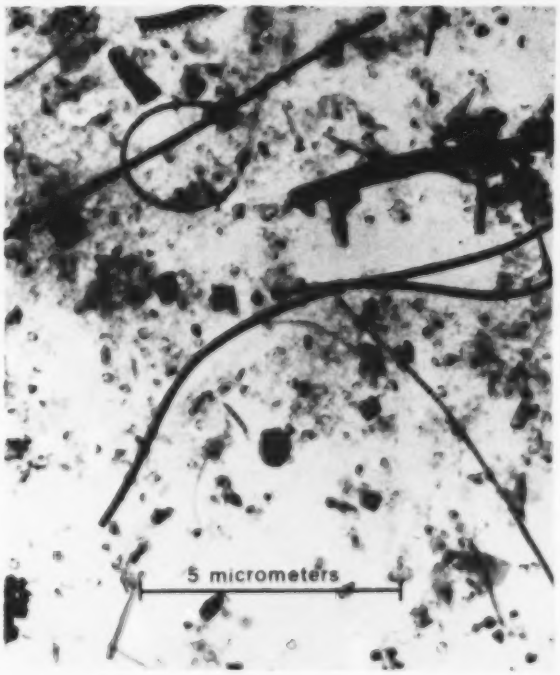
ENVIRONMENTAL RESEARCH LABORATORY

Asbestos research at the Environmental Research Laboratory (ERL) - Duluth originated in 1973 when analysis of Duluth, Minnesota drinking water revealed high amphibole fiber concentrations associated with mine tailings discharged into Lake Superior. The similarity of these fibers to amosite asbestos and concern for the health of persons ingesting them created numerous research questions which EPA's Office of General Council, Region V and the State of Minnesota requested ERL-Duluth to work on. Electron microscope methods for counting and sizing fibers in water and air samples were developed and correlated to x-ray diffraction measurements which proved to be a useful and inexpensive indicator of amphibole fiber concentrations. These methods formed the basis for the development of the EPA Interim Method for Determining Asbestos in Water and the EPA Provisional Method for Electron Microscope Measurement of Airborne Asbestos Concentrations.

In recent years ERL-Duluth has adapted the electron microscope techniques for water and air analysis to examination of tissue and urine. The finding of amphibole fibers in the urine of Duluth residents who ingested unfiltered drinking water contaminated with the fibers provided the first evidence that some ingested mineral fibers can pass through the gastrointestinal mucosa and thus be absorbed by the body. Analysis of Lake Superior lake trout indicates that amphibole fibers are accumulated by the fish in the kidney but not significantly in muscle tissue.

Research questions that arose with the Lake Superior water situation have been restated many times since 1973 as problems with mineral and synthetic fibers similar to asbestos have developed. The most important question

Rock fragments from quarry material used in road construction consisting mainly of barroisite (an aluminum rich amphibole)



Electron micrograph of Duluth drinking water

Electron micrograph of barroisite after grinding to produce fine dust (magnified approximately 4,500 X; 1 cm equals 2.2μ)

invariably has been, "Which fibers are hazardous?" Are short asbestos fibers found in the environment carcinogenic, as are asbestos fibers in past occupational exposures? Do particles from commercial asbestos possess some property related to their carcinogenicity that similar particles from other sources do not? Current ERL-Duluth research seeks to help answer these questions through studies of the physical, chemical and crystalographic properties of asbestos and analogous mineral and synthetic fibers for which biological effects data is available or is being collected. Much of this work is done cooperatively with HERL-RTP which is conducting *in vivo* and *in vitro* tests of the same fiber samples being characterized at ERL-Duluth.

Accurate determinations of fiber dose, size distribution, and other characteristics are essential for the correlation of carcinogenicity to sample properties and the ultimate development of a model to predict the relative carcinogenicity of complex unknown fiber samples. Related work on tissues of exposed animals exphasizes the importance of understanding fiber behavior *in vivo* as a factor related to carcinogenesis.

Project Title: IDENTIFY PHYSICAL, MORPHOLOGICAL, CHEMICAL, AND CRYSTALOGRAPHIC PROPERTIES OF FINE PARTICLES WHICH GOVERN THEIR BIOLOGICAL ACTIVITY

Starting Date: December, 1979

Ending Date: December, 1983

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Abstract: The ultimate objective of this cooperative interlaboratory research program is to design inexpensive and short-term tests for assessing the relative biological activity and carcinogenicity of unknown, complex mineral dust samples.

Exposure to asbestos fibers is a major occupational and environmental health problem. The control of dust emissions, particularly for mining activities, has increasingly been complicated by concern about mineral particles with varying degrees of similarity to mineral fibers being released from asbestos mining and milling. The preparation and characterization of mineral particle samples selected for biological testing is a critical step in this research since accurate, unambiguous descriptions of different particle properties and characteristics are needed in order to learn which factors control biological activity.

The fiber concentration and size distribution of each test sample must be accurately determined by transmission electron microscopy (tem). Other measurements to be made are as follows: 1) electron microscope determination of contaminant particles

and % total mass present as particles to be tested; 2) x-ray diffraction determination of mineral mass concentration and presence of mineral impurities; 3) energy dispersive x-ray fluorescence analysis of particle chemistry; 4) selected area electron diffraction identification of minerals and mineral fiber orientations including identification of preferred crystal faces; 5) scanning electron microscopy of particle surface features; 6) crystal lattice imaging (tem) to determine type and density of crystal internal defect structures in representative particles; 7) particle and total sample areas and zeta potential; 8) exploration of methods for measurement of physical properties of microscopic particles, such as tensile strength, which may determine biological activity; and 9) leaching tests to determine particle durability. Transmission electron microscope examination of exposed animal tissue will quantitatively measure particle retention as a function of time, size, shape, chemistry, crystalography, and asbestiform character.

Characterization of mineral fiber samples used in intraplural and intratracheal injection studies with rats at HERL - RTP is in progress and sample properties are being related to tumor production in each test. Initial results indicate that fiber length may not be the most important criterion for carcinogenicity of inhaled mineral fibers. The single most important characteristic of these fibers, related to their carcinogenicity, appears to be the ability to break down into many thinner fibers while residing within the tissue.

*This study is being conducted in collaboration with the Health Effects Research laboratory - Research Triangle Park. See also, Evaluation of Health Effects and Toxic Potential of Nonasbestos Mineral Fibers, HERL-RTP, D. Coffin.

Project Title: INFLUENCE OF DRINKING WATER FINE PARTICLE CONCENTRATIONS ON PASSAGE OF FINE PARTICLES THROUGH HUMAN URINARY TRACT

Starting Date: February, 1978

Ending Date: December, 1981

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Abstract: The purpose of this study is to determine the number of microscopic particles, especially mineral fibers, ingested with drinking water, that may be absorbed by the body and eventually eliminated via the urinary tract. In addition, time relationships for particle accumulation and retention will be obtained. Particular attention will be placed on the impact of a municipal water filtration plant on the reduction of urine particle concentrations.

Approximately 170 urine samples were systematically collected from 12 residents of Two Harbors, Minnesota during 1978, before and after installation of a filtration plant to remove amphibole fibers from the water supply (spring 1978). Sample preparation and transmission electron microscope analysis for urine fiber concentrations is in progress. Water supply fiber concentrations for the sampling period have been determined and indicate approximately 99% removal of amphibole fibers from raw water. The time relationship of human urine fiber concentrations to drinking water exposure will be determined when microscope analysis of urine samples is complete.

This study is now being conducted in conjunction with, Quantitative Electron Microscope Analyses of Tissue for Human Inorganic Particle Exposure Assessment, ERL-Duluth, P. Cook.

ERL-DU

Project Title: QUANTITATIVE ELECTRON MICROSCOPE ANALYSIS OF TISSUE FOR HUMAN INORGANIC PARTICLE EXPOSURE ASSESSMENT

Starting Date: January, 1979

Ending Date: December, 1981

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Investigator: P.M. Cook
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Abstract: This research is being conducted to quantify the tissue accumulation of microscopic particles, such as asbestos fibers and fly ash, as a consequence of human and animal exposure, particularly from contaminated water, beverages, and food.

Bulk tissue particle concentrations are being compared to concentrations and characteristics of exposure particles. Tissue samples from animals and humans exposed to known concentrations of microscopic particles such as asbestos fibers are examined by quantitative transmission electron microscopy. Fibers and other particles in tissue are identified by selected area electron diffraction and energy dispersive x-ray fluorescence analysis. If tissue preparation techniques developed are sufficiently sensitive to allow detection of individual particles, fiber transport to various organs will be studied with regard to relative concentrations, particle size differences, and chemical alteration. An estimate of total body burden of mineral fibers will be compared to total ingestion exposure and urine elimination in order to estimate the fraction of ingested mineral fibers which pass the gastrointestinal mucosa. Human tissue fiber concentrations resulting from environmental

exposure will be compared to like tissues from occupationally exposed individuals.

This study is now being conducted in conjunction with, Influence of Drinking Water Fine Particle Concentrations on Passage of Fine Particles Through Human Urinary Tract, ERL-Duluth, P. Cook.

ERL-DU

Project Title: METHOD FOR IDENTIFICATION AND CONCENTRATION MEASUREMENT OF FINE PARTICLES IN AQUATIC ORGANISMS

Starting Date: January, 1979

Ending Date: August, 1980

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Investigator: A. R. Batterman
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Abstract: The objective of this study is to develop, evaluate, and use electron microscope procedures for identification and concentration determination of fine particles, including asbestos fibers, in tissue from aquatic organisms that have been exposed to such fine particles.

Tissue samples from lake trout, brook trout, catfish, and Arctic char are being carefully examined by transmission electron microscopy. The lake trout, brook trout, and catfish were exposed to amphibole fibers in Lake Superior water (approximately 50×10^6 amphibole fibers/liter). These fibers were found in muscle, liver and kidney samples. The Arctic char were exposed to chrysotile asbestos fibers which were also found in muscle and kidney samples. However, chrysotile is a common contaminant, which makes it extremely difficult to attribute chrysotile fiber content to bioaccumulation.

Preliminary findings show fish can accumulate mineral fibers in tissues; muscle fiber concentrations appear to be 1/12 the water fiber concentrations, kidney fiber concentrations appear to be as much as 40 times higher than water concentrations. Comparison of lake trout captured from Lake Superior areas with and without amphibole fiber-free diet in Lake Superior water containing amphibole fibers have barely detectable fiber concentrations, however, exact determination of fiber ingestion uptake as a function of food chain exposure concentration and particle size distribution will require a controlled laboratory exposure of fish to a well characterized diet for an extended period of time. A report summarizing this study is forthcoming.

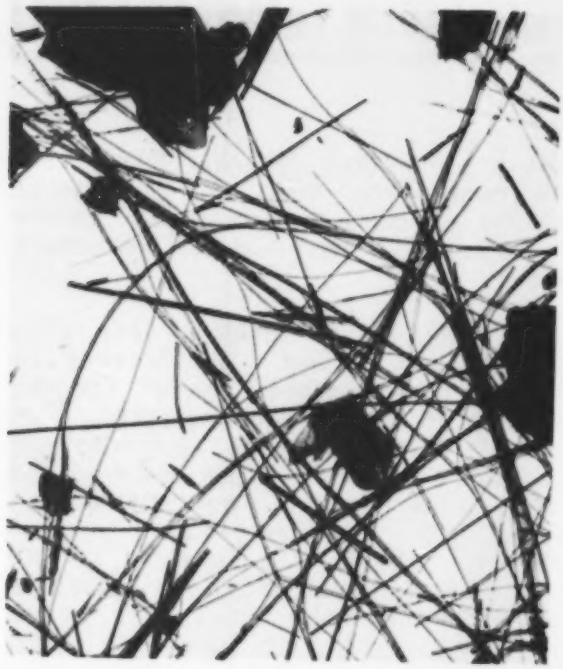
RESEARCH TRIANGLE PARK

ENVIRONMENTAL SCIENCE RESEARCH LABORATORY

Electron microscopy is currently the principal method used to identify and characterize asbestos fibers in ambient air and water samples. Though slow and expensive, this method yields much information of importance in assessing population exposure and health risk, including fiber count and mass concentrations, and fiber diameters and lengths. Because of significant variations in technique, however, comparisons of data from different laboratories have shown wide discrepancies in results for the same samples. This situation prompted a two-year in-depth study, by the Environmental Science Research Laboratory (ESRL) - Research Triangle Park, that has produced and validated a provisional optimum electron microscope procedure for use as a research or reference method.

Substantial progress has also been made in other ESRL efforts to develop new methodology needed for the measurement of airborne asbestos. In one of these projects, a prototype asbestos analyzer has been designed and built using special x-ray diffraction optics and involving prealignment of asbestos fibers in a sample. It can detect submicrogram amounts of asbestos and measure them quantitatively.

Electron microscope



Electron micrograph showing chrysotile asbestos insulating materia' (magnified 500 times)

Electron micrograph showing chrysotile asbestos insulating material (magnified 2,000 times)

Because equipment cost and time per analysis are both far less than for electron microscopy, as much as a tenfold reduction in cost per analysis may be possible. Thus this technique appears promising as a rapid, low-cost screening method for routine application.

In another project, an aerosol fiber counter has been designed and built using two detectors that identify fibers on the basis of light-scattering dissymmetry. Initial tests of the counter have shown it to be an effective continuous monitor for asbestos fibers. This type of instrument should be useful for problem assessment, for rapid screening and for checking the effectiveness of control measures.

Project Title: APPLICATION OF AN ASBESTOS ANALYSIS TO ENVIRONMENTAL SAMPLES

Starting Date: January, 1979

Ending Date: December, 1980

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Radiation Technology Division
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Investigator: L.S. Birks
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Abstract: In order to develop a rapid bulk analytical method for the measurement of airborne asbestos, a prototype asbestos analyzer has been designed and built by the Naval Research Laboratory (NRL) using special x-ray diffraction optics and involving prealignment of asbestos fibers in a sample. It can detect submicrogram amounts of asbestos and measure them quantitatively. A final report was published, Birks, L.S., Gilfrich, J.V., and Sandelin, J.W., "X-ray Analysis of Airborne Asbestos." EPA-600/2-78-194, August, 1978.

The objectives of this study were: (1) to evaluate the performance of the x-ray Diffraction Asbestos Analyzer (XRDAA) designed and built by NRL under a previous agreement, and (2) to determine operating costs and analysis time involved in its routine use.

Sample specimens were prepared by EPA using separation techniques currently under development and using fiber alignment as perfected in ESRL-RTP. NRL furnished alignment grids, operated analyzer, and evaluated results.

The study revealed that 0.1 micrograms of Asbestos (chrysotile or amosite) are detectable in 500-second measurements. Work continues on sample preparation techniques.

ESRL-RTP

Project Title: FEASIBILITY STUDY FOR AN ASBESTOS AEROSOL MONITOR

Starting Date: July, 1976

Ending Date: June, 1978

EPA Project Officer: Jack Wagman
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Emissions Measurement and Characterization Division
Environmental Sciences Research Laboratory
Research Triangle Park, North Carolina 27711

Performing Organization: University of Vermont & State Agricultural College
School of Arts & Sciences
85 S. Prospect Street
Burlington, Vermont 05401

Investigators: R.W. Detenbeck, D.R. Hemenway, Department of Physics
Tel. (802) 656-3036

Abstract: A light-scattering aerosol-fiber counter, designed to facilitate the monitoring of airborne asbestos fibers, has been constructed and subjected to initial tests. The counter can discriminate among particle shapes, as well as sizes, by employing more than one photodetector. The project is a feasibility study for a continuous-flow, light scattering aerosol counter which can discriminate asbestos fibers from more symmetric shapes by their light-scattering signatures.

The optical system can count randomly oriented respirable fibers with about 25 percent efficiency, but its efficiency has been increased by aligning the particles in a combination of electrical and fluid-velocity-gradient fields.

Fabrication of a breadboard instrument has been completed. This instrument is being evaluated using laboratory-generated fibrous and nonfibrous aerosols.

A final report has been prepared and will be published shortly.

Project Title: DEVELOPMENT OF GLASS ARRAY IMPACTORS FOR SEPARATION OF FIBROUS AEROSOLS

Starting Date: June, 1979

Ending Date: June, 1981

EPA Project Officer: Jack Wagman
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Environmental Sciences Research Laboratory
Research Triangle Park, North Carolina 27711

Performing Organization: University of Maryland
College Park Campus
School of Engineering
College Park, Maryland 20742

Investigator: J.W. Gentry, Department of Chemical Engineering
Tel. (301) 454-5098

Abstract: The objective of this research is to develop a means for sampling fibrous aerosols that will separate fibers from nonfibrous or isometric particles and thus facilitate the measurement of airborne fiber concentrations, e.g., of asbestos, by reducing interferences by background particles.

The approach is based on previously reported observations that fibers are aligned by flow gradients as they approach and pass through parallel capillary arrays, such as Nucleopore® filters and porous glass disks of sufficiently large pore size.

ESRL-RTP

Project Title: EVALUATION OF ELECTRON MICROSCOPE METHODS FOR MEASUREMENT OF AIRBORNE ASBESTOS CONCENTRATIONS AND EVOLVEMENT OF AN OPTIMAL PROCEDURE

Starting Date: May, 1975

Ending Date: May, 1977

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Environmental Sciences Research Laboratory
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Performing Organization: IIT Research Institute
10 West 35th Street
Chicago, Illinois 60616

Investigators: A.V. Samudra, C.F. Harwood
Tel. (312) 567-4160

Abstract: Currently, the electron microscope is the only instrument capable of defining the morphology, chemistry, and crystal structure of asbestos fibers. Several laboratories perform the analysis for airborne asbestos fibers, and while they have reasonable internal self-consistency, the results obtained by the separate laboratories are often widely different. The objective of this program is to evaluate the various methods currently in use in the various laboratories, statistically evaluate the subprocedures used, and arrive at an optimum composite procedure. The optimum procedures will be tested and statistically evaluated. A handbook on the optimum procedure will be written in which detailed instructions on the method will be given without any ambiguity. Samples will be sent out to other laboratories for analysis using the optimum procedure as described in the manual. The interlaboratory results will then be evaluated.

A provisional methodology manual was published, Samudra, A.V., Harwood, C.F., Stockham, J.D., "Electron Microscope Measurement of Airborne Asbestos Concentrations." EPA-600/2-77-178, August 1977 (revised in June 1978).

*See also Evaluation and Collaborative Testing of the Provisional Method for Measurement of Airborne Asbestos, EMSL - Research Triangle Park, M. Beard.

Project Title: MORPHOLOGY AND COMPOSITION OF PARTICULATES EMITTED BY MOBILE AND STATIONARY SOURCES

Starting Date: September, 1972

Ending Date: September, 1981

EPA Project Officer: Fred Haynie
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Emissions Measurement & Characterization Division
Environmental Sciences Research Laboratory
Research Triangle Park, North Carolina 27711

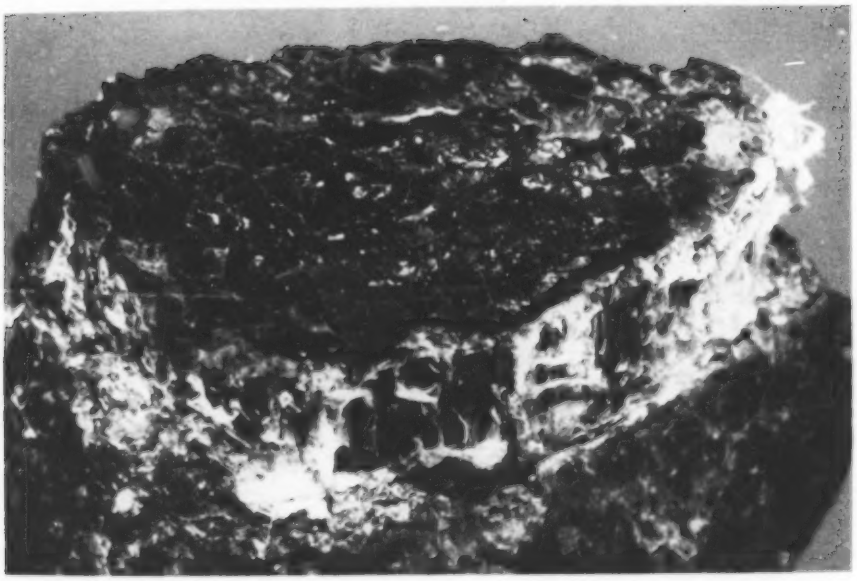
Performing Organization: U.S. Environmental Protection Agency
Emissions Measurement & Characterization Division
Environmental Sciences Research Laboratory
Research Triangle Park, North Carolina 27711

Investigators: J.L. Miller
Tel. (919) 541-2425

Abstract: This study, using electron-optical techniques, is being conducted to determine the morphology and elemental composition of particulate matter emitted by mobile sources.

The analyses will be carried out using transmission and scanning electron microscopy in conjunction with electron diffraction, electron microprobe measurements, and advanced image analysis techniques.

Particulate sources currently under study include automobile brake linings and diesel engines, and specific items being studied include lead and asbestos samples.



Serpentine asbestos in rock formation

ENVIRONMENTAL RESEARCH LABORATORY

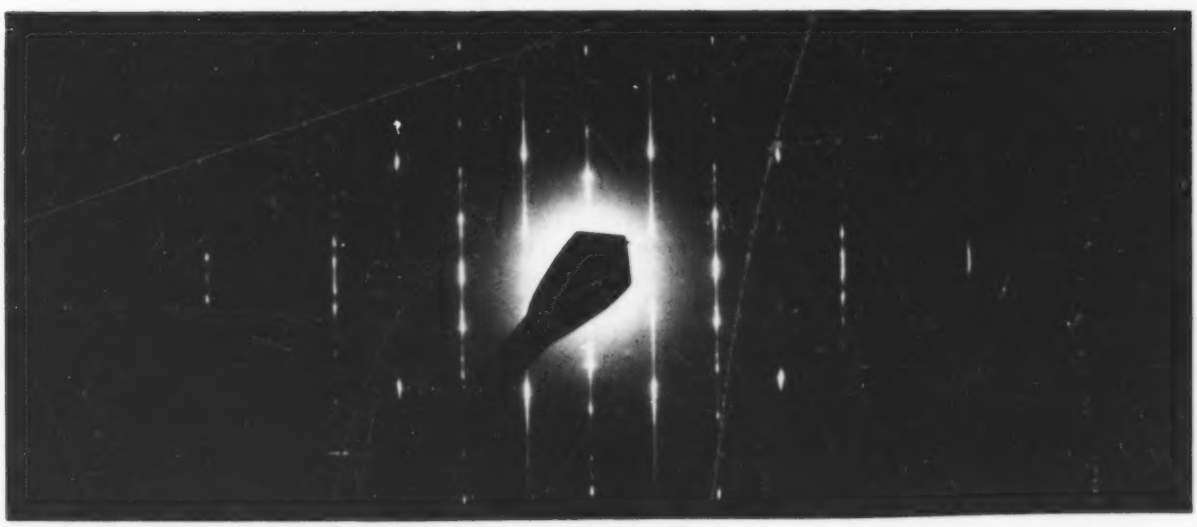
ATHENS

Because of the widespread use of asbestos and asbestos-containing materials, and the hazards associated with exposure to these minerals, the study of the health and environmental effects of exposure are essential. The Environmental Research Laboratory (ERL) - Athens conducts research on the occurrence, movement, transformation, impact, and control of environmental contaminants, and develops new techniques for identifying chemical constituents of water and soil.

ERL-Athens has been involved in the development and improvement of an interim analytical method for the accurate measurement of asbestos in water using an electron microscope, as well as a simple rapid screening method that can be used for the preliminary examination of a large number of water samples.

Although microscopy has proven to be an effective technique for identifying and measuring asbestos in water, no consensus has been reached among analytical chemists concerning the effects of storing water samples of asbestos and no data has been developed on the effects of different storage techniques. This storage problem is of considerable concern to analytical chemists, particularly in the development of analytical protocols. ERL-Athens is studying the effect of preservatives and storage techniques on the size distribution of asbestos particles in water.

Chrysotile asbestos fibers (magnified 50,000 X)



Electron diffraction pattern of chrysotile asbestos

ERL-ATH

Project Title: INVESTIGATING THE EFFECT OF PRESERVATION/STORAGE TECHNIQUES

Starting Date: January, 1979

Ending Date: January, 1981

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Performing Organization: U.S. Environmental Protection Agency
Analytical Chemistry Branch
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College Station Road
Athens, Georgia 30605

Investigator: J. M. Long
Tel. (404) 546-3525

Abstract: The objective of this research is the investigation of the effect of preservatives and storage techniques to determine their effect on size distribution of asbestos particles. The long-term effects of mercuric chloride preservative and cold storage are being studied.

Athens laboratory research shows that lake water refrigerated for approximately 1 year and treated with ultrasound prior to sample preparation showed the same asbestos fiber concentration as the control samples. When the stored lake water samples were merely shaken by hand without the ultrasound prior to sample preparation, however, the fiber concentration was significantly lower ($p=0.05$) than that of the control.

This ultrasound treatment together with refrigerated storage can now be specified for samples that cannot be analyzed immediately. Mercuric chloride is used to prevent bacterial growth in water samples during storage, but no information has been available on the effects of the preservative on accurate measurement of stored chrysotile asbestos. Recent studies demonstrated that accurate measurement by electron microscopy could be obtained for chrysotile stored for as long as 6 months. All samples received ultrasound treatment prior to specimen grid preparation. Comparison of the preserved samples with the controls showed that the mercuric chloride had no significant effect (0.01 Student t-test) on fiber concentration for either storage time. The finding allows analytical chemists to store these samples with confidence that initial measurement after storage--or repeat measurement after storage--will accurately reveal fiber concentraiton.

Project Title: DEVELOPMENT OF A ROUTINE RAPID METHOD FOR ANALYZING ASBESTOS IN WATER (NON-ELECTRON MICROSCOPE METHOD)

Starting Date: June, 1975

Ending Date: June, 1978

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Performing Organization: Battelle Memorial Institute
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Investigator: C.W. Melton
Tel. (614) 424-6424

Abstract: The objective of this contract was to develop a method for rapidly analyzing water samples for asbestos content through new and unique and simple approaches that did not depend upon electron microscopy.

During the first year, methods of asbestos separation based on continuous particle electrophoresis, dielectric constant, and solvent extraction were investigated. During the second year, simple methods of quantitation of the separated asbestos were developed. This research led to the development of a separation technique involving the extraction of chrysotile from a water sample into an immersible organic liquid phase. This procedure is referred to as two-phase liquid separation. In addition, a light microscope counting technique and a colorimetric spot test detection technique were also developed and combined with the liquid separation procedure.

Results indicate that 75 percent of the chrysotile is extracted by the two-phase liquid separation procedures. The results of the research are summarized in, Melton, C.W., Anderson, S.J., Dye, C.F., Chase, W.E., and Heffelfinger, R.E., "Development of a Rapid Analytical Method for Determining Asbestos in Water." EPA-600/4-78-006, December, 1978.

ERL-ATH

Project Title: DEVELOPMENT OF A REFEREE METHOD FOR ASBESTOS IN WATER USING THE ELECTRON MICROSCOPE

Starting Date: September, 1974

Ending Date: September, 1981

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Performing Organizations: U.S. Environmental Protection Agency
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Ontario Research Foundation
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Investigators: J.M. Long; E.J. Chatfield, Electron Optics Laboratory
Tel. (416) 424-3525

Abstract: This study is a continuation of an earlier study that established sample preparation techniques and examined alternative transfer techniques. The objectives of this research are to obtain a more positive identification of amphibole asbestos, to refine the techniques for eliminating organic matter prior to analysis in order to preserve the integrity of the sample, and to develop methods for the physical and chemical characterization of particulates. The ultimate objective is to write a referee method.

To date, an interim method has been written, Anderson, C.H., and Long, J.M., "Interim method for Determining Asbestos in Water." EPA-600/4-80-005, January 1980. This method involves: 1) separation of fibers from water by filtration on a submicron pore size membrane filter; 2) counting the fibers, after dissolving the filter material, by direct observation in a transmission electron microscope; and 3) verifying fiber identity by selected area diffraction.

It appears that the ozone-UV treatment of water samples to remove organics is potentially superior to the technique of low temperature plasma ashing. Light scattering methods are also being developed as a means of rapidly measuring asbestos in water.

INTERAGENCY AND OTHER ORD RESEARCH PROJECTS

The Office of Research and Development conducts asbestos research in cooperation with other federal departments. These include: U.S. Department of Health and Human Services, National Institute of Environmental Health Sciences and the National Institute for Occupational Safety and Health; U.S. Department of Commerce, National Bureau of Standards; and the U.S. Department of Energy, Oak Ridge National Laboratory.

In addition, the Environmental Research Laboratory (ERL) - Gulf Breeze has included asbestos in one portion of their overall carcinogen research project.

INTERAGENCY

Project Title: STUDY OF CARCINOGENIC POTENTIAL OF ASBESTOS FIBERS ON RODENTS

Starting Date: August, 1977

Ending Date: September, 1982

Project Officers:

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Performing Organization: National Institute of Environmental Health Sciences
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Investigator: J.A. Moore
Tel. (919) 541-3267

Abstract: The research project will generate technical data needed to assess the carcinogenic potential of orally administered asbestos fibers.

The NIEHS/EPA oral asbestos studies in rats and hamsters represent a systematic attempt to assess the biological effects associated with primary ingestion of selected asbestos fibers. The objectives of the studies include: assessing of biological (carcinogenic) effects as a consequence of exposure to one of several types of asbestos, and assessing if an interaction exists between a chemical carcinogen that is known to produce bowel cancer, and ingestion of asbestos.

The summary of this research is published in Moore, J.A., "NIEHS Oral Asbestos Studies." National Bureau of Standards Special Publication 506, Proceedings of the Workshop on Asbestos: Definitions and Measurement Methods held at NBS, Gaithersburg, MD, July 18-20, 1977. (Issued November 1978).

The protocol includes long-term studies of the rat and hamster, aimed at the elucidation of the carcinogenic and co-carcinogenic role of asbestiform fibers.

Project Title: ELEMENTAL ANALYSES OF ASBESTIFORM MINERALS

Starting Date: October, 1979

Ending Date: September, 1980

Project Officers:

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Investigators:

A.R. Brody, L. Hill
Tel. (919) 541-3243; FTS: 629-3243

Abstract:

The elemental content of inhalable inorganic particles may play an important role in cytotoxic events leading to pulmonary disease. There is substantial evidence that the size and shape of asbestos fibers are also critical factors. The purpose of this research was to determine which of these factors was the most important, through *in vitro* experiments using pulmonary cells, such as alveolar macrophages, and through animal inhalation studies where cytotoxic dusts can be investigated *in situ*.

Transmission and scanning electron microscopy in concert with x-ray energy spectrometry showed that significant amounts of Mg had slowly leached from asbestos fibers after one month in 2.5% glutaraldehyde. Treatment with 1N HCl caused a rapid (one hour) loss of significant Mg content which reached a plateau at about 4 hours. In contrast, two hours after phagocytosis by alveolar macrophages, no Mg loss was detected. Chrysotile fibers in the lungs of rats showed considerable variability in Mg content. A report, to be published in J. of Environ. Pathol. & Toxicol., is forthcoming.

INTERAGENCY

Project Title: STANDARD REFERENCE MATERIALS FOR ASBESTOS IN AIR

Starting Date: March, 1978

Ending Date: September, 1981

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Performing Organization:

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Investigators:

J. Small, E. Steel
Tel. (301) 921-2875

Abstract:

The objective of this research is to provide calibration standards and evaluate basic measurement methods for asbestos in the atmosphere.

The approach involves the development of Transmission Electron Microscope (TEM) grid research materials consisting of chrysotile and amphibole asbestos in an urban air particulate matrix. In addition, 0.2 μ Nucleopore® filter research materials with known concentrations and distributions of chrysotile and/or amphibole asbestos in an urban air particulate are being developed.

Round Robin testing with TEM grid research materials has begun. A workshop was held in October, 1980 to discuss the preparation and analysis of the standards.

*See also Standard Reference Material for Asbestos in Air, EMSL - Research Triangle Park, M. Beard.

Project Title: INSULATING MATERIALS, LONG-TERM INHALATION EFFECTS

Starting Date: October, 1977

Ending Date: October, 1981

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Performing Organization:

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Investigator:

R. Mitchell
Tel. (614) 424-7441

Abstract:

Chronic biologic effects following long-term inhalation of fibrous glass used in insulating trades are being studied via the contractual route. Specific objectives include: 1) the evaluation of carcinogenic risk; 2) the evaluation of the fibrogenic potential; and 3) the character of pulmonary responses, both physiological and pathological (including deposition patterns). The results from this effort will be useful in evaluating the validity of the NIOSH-proposed standard.

Animal inhalation toxicologic studies are being conducted on a 7 hr/day, 35 hr/wk, 18-month exposure regimen. Four treatment groups plus one control group are being used. Two groups will have a total mass of 15 mg/cu.m and two groups will have a total mass of 5 mg/cu.m. Within the 15 mg/cu.m exposures, one group will have fibers 4-6μ diameter and greater than 20μ length; the other will have fibers 1μ diameter and greater than 10μ length. Both of the 15 mg/cu.m treatment groups will receive fiber with binder. The 5 mg/cu.m groups will receive fibers 1μ in diameter; the first group will have fibers longer than 10μ in length and the

second group will have fibers less than 10μ in length. Neither of these groups will receive fiber with binder.

Two species of laboratory animals will be required. Fifty male and fifty female rats and twelve male cynomolgus monkeys are in each treatment group.

Clinical chemistry determinations will be performed on all monkeys prior to exposure and at the terminal sacrifice. Rats will be tested at termination only. Pulmonary function tests will be performed on all monkeys at baseline and after 9 and 18 months of exposure. Gross and histopathological examinations will be conducted on all animals which are moribund, die spontaneously, or are sacrificed.

Project Title: MORTALITY AND INDUSTRIAL HYGIENE STUDY OF WORKERS IN COAL FIRED POWER PLANTS

Starting Date: October, 1976

Ending Date: September, 1981

Project Officers:

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Investigators:

J. Costello, W. Jones
Tel. (304) 599-7476

T. Waters
Tel. (615) 755-3345

Abstract: Pulmonary diseases and impairments such as airway obstructive diseases and pneumoconiotic lesions, could arise in part from exposures to gases emitted during coal combustion and exposures to coal dust when coal is burned as fuel for steam-powered electricity-generating plants. Those workers who handled the asbestos sheets used to insulate steam pipes may also show evidence of health damage -- asbestosis or malignancies. In order to conduct research on occupational safety and health problems of TVA employees, a memorandum of understanding between the NIOSH and TVA was signed in 1976 specifying overall responsibilities for cooperative studies.

Sub-agreement I under this memorandum established Industrial Hygiene studies of workers in coal-fired power plants. The TVA will conduct detailed cross-sectional Industrial Hygiene studies of workers in selected occupations. Existing industrial hygiene data of past exposures, along with information on control methods will be reviewed in order to retrospectively estimate cumulative working lifetime exposures in

occupations where there has been exposure to particulates or gases. This information will be used to attempt dose assessment for mortality studies of workers exposed to these same pollutants in the past.

Sub-agreement II, Epidemiological Mortality Study of TVA Employees, estimates the effects in terms of higher-than-expected death rates and/or early retirement due to disability involving principally cardiopulmonary disease or specified malignancies linked to earlier exposures to air contaminants in the workplace environment.

Project Title: COMPLETION OF REEP DOCUMENTS AND INCORPORATION OF TECHNICAL REVIEWS

Starting Date: July, 1975

Ending Date: January, 1979

Project Officers:

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Performing Organization:

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Oak Ridge, Tennessee 37830

Investigator:

Tim Ensminger
Tel. (615) 574-7794; FTS: 624-7794

Abstract:

The "Reviews of the Environmental Effects of Pollutants" series (REEPS) represents an extensive completion of relevant research and forms an up-to-date compendium of the environmental effect data on selected pollutants. The REEP documents contain a general summary and comprehensive discussion of the following topics as they relate to each compound: occurrence; synthesis and use; analytical methodology; biological aspects in microorganisms, plants, wild and domestic animals, and humans; persistence in the environment, and an assessment of present and potential environmental hazards. Current research needs are also included.

Reviews of the following pollutants have been prepared: Mercury, Cadmium, Chromium, Endrin, Mirex/Kepone, Cyanides, Benzidine, Chlorophenols, Beryllium, Toxaphene, Fluoride, and Hexachlorocyclopentadiene. The REEP for Asbestos is currently in preparation, and is awaiting a final environmental assessment chapter.

INTERAGENCY

Project Title: DEVELOPMENT OF A FLOWING WATER CARCINOGEN ASSAY SYSTEM UTILIZING FISH AND AQUATIC INVERTEBRATES

Starting Date: September, 1978

Ending Date: September, 1984

EPA Project Officer: John A. Couch
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Environmental Research Laboratory
Sabine Island; Gulf Breeze, Florida 32561

Performing Organization: U.S. Environmental Protection Agency
Environmental Research Laboratory
Sabine Island; Gulf Breeze, Florida 32561

Investigators: J.A. Couch, W.P. Schoor, L.A. Courtney, J.T. Winstead, S.S. Foss
Tel. (904) 932-5311

Abstract: The purpose of this study is to provide information on the fate and effects of carcinogens in the aquatic environment and to develop carcinogen assays utilizing aquatic species to supplement mammalian assays.

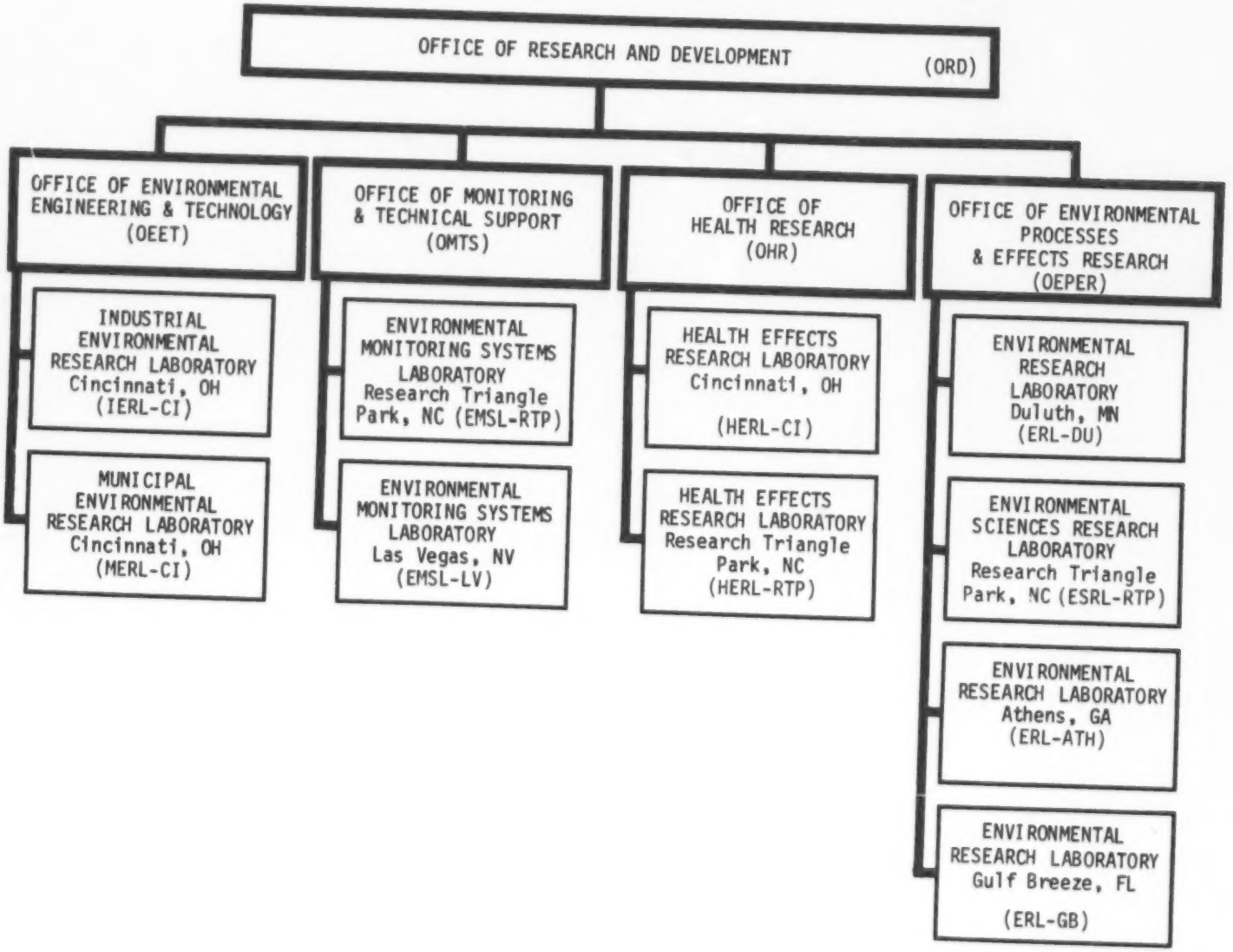
The approach is as follows: 1) design experimental flow-through and static systems for exposing aquatic organisms to carcinogens or suspect chemicals; 2) select and test marine and freshwater species for their responsiveness and sensitivity to known or suspect carcinogens; 3) compare oncogenic sensitivity of aquatic species and standard mammalian test species to known carcinogens; 4) obtain uptake, bioconcentration, and metabolic data on carcinogens in aquatic animals.

A fish carcinogen assay exposure system has been designed, constructed, and is now being tested in long-term exposures of fishes to the pesticide Trifluralin, a suspect carcinogen. Reports on the use of oysters as bioindicators of carcinogens, demonstrated experimentally in the laboratory, have been published. Research on the fate and effects of asbestos on fish has begun.

To date, an aquarium fish, the glass perch, has been injected with asbestos particles intraperitoneally and maintained for over six months. Some of the fish have been examined histologically with few or no effects of the asbestos revealed. Work is continuing with the aquarium fish in order to determine the fate of asbestos in the living animal. A report summarizing the overall carcinogen research is in press, Couch, J.A., Schoor, W.P, "Progress Report on the NCI/EPA Collaborative Program. Project 3: Effects of Carcinogens, Mutagens and Teratogens on Nonhuman Species (Aquatic Animals)," H. Kraybill, ed.

• U.S. GOVERNMENT PRINTING OFFICE: 1981-757-064/0289

ORD Laboratories Active in Asbestos Research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OFFICE OF ENVIRONMENTAL ENGINEERING & TECHNOLOGY (OEET)
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ENVIRONMENTAL RESEARCH LABORATORY Gulf Breeze, FL (ERL-GB)